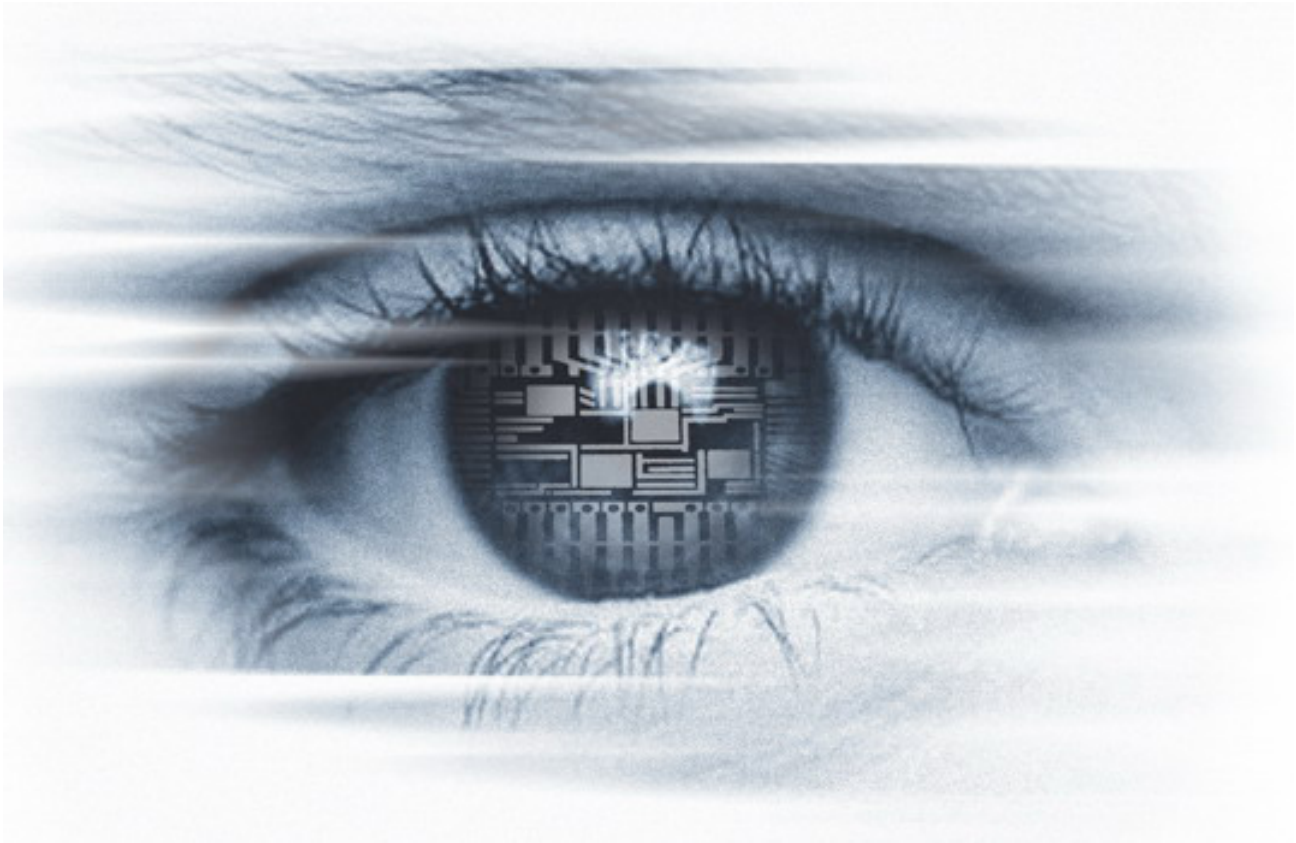
User Manual

MV1-R1280-50-G2 Camera Series

Ultra low light CMOS camera with GigE interface



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1 Preface

1.1 About Photonfocus

The Swiss company Photonfocus is one of the leading specialists in the development of CMOS image sensors and corresponding industrial cameras for machine vision.

Photonfocus is dedicated to making the latest generation of CMOS technology commercially available. Active Pixel Sensor (APS) and global shutter technologies enable high speed and high dynamic range (120 dB) applications, while avoiding disadvantages like image lag, blooming and smear.

Photonfocus' product range is complemented by custom design solutions in the area of camera electronics and CMOS image sensors.

Photonfocus is ISO 9001 certified. All products are produced with the latest techniques in order to ensure the highest degree of quality.

1.2 Contact

Photonfocus AG, Bahnhofplatz 10, CH-8853 Lachen SZ, Switzerland

Sales	Phone: +41 55 451 00 00	Email: sales@photonfocus.com
Support	Phone: +41 55 451 00 00	Email: support@photonfocus.com

Table 1.1: Photonfocus Contact

1.3 Sales Offices

Photonfocus products are available through an extensive international distribution network and through our key account managers. Contacts to our key account managers can be found at www.photonfocus.com.

1.4 Further information

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1.5 Legend

In this documentation the reader's attention is drawn to the following icons:

Important note

Alerts and additional information

Attention, critical warning

Notification, user guide

2

Introduction

2.1 MV1-R1280 Introduction

The Photonfocus MV1-R1280 camera series is built around a ultra-low noise CMOS image sensor with a high dynamic range.

The image sensor uses an innovative integration mode and an advanced analog to digital conversion (ADC) to achieve a read out noise of less than $1e^-$.

Fig. 2.1 shows the impressive low light performance of the MV1-R1280 camera by showing a comparison with the MV1-D2048x1088 camera with a CMOSIS CMV2000 sensor. Both images were shot at the same illumination and with an exposure time of 30 ms. The left-hand image was shot at a gain of 128 with a MV1-D2048x1088 camera that is known for his good sensitivity. The right-hand image was shot with the MV1-R1280 camera at room temperature with a gain of 256.

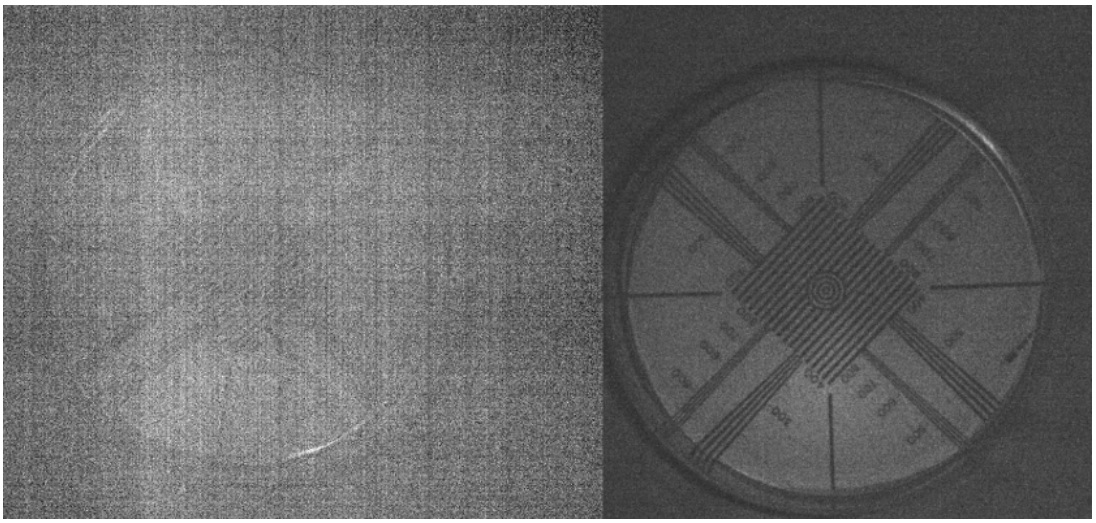

Figure 2.1: Photonfocus MV1-D2048x1088 (left) versus MV1-R1280 (right) low light performance

3 How to get started (GigE G2)

3.1 Introduction

This guide shows you:

- How to install the required hardware (see Section 3.2)
- How to install the required software (see Section 3.3) and configure the Network Adapter Card (see Section 3.4 and Section 3.5)
- How to acquire your first images and how to modify camera settings (see Section 3.6)
- A Starter Guide [MAN051] can be downloaded from the Photonfocus support page. It describes how to access Photonfocus GigE cameras from various third-party tools.

3.2 Hardware Installation

The hardware installation that is required for this guide is described in this section.

The following hardware is required:

- PC with Microsoft Windows OS (XP, Vista, Windows 7, Windows 8)
- A Gigabit Ethernet network interface card (NIC) must be installed in the PC. The NIC should support jumbo frames of at least 9014 bytes. In this guide the Intel PRO/1000 GT desktop adapter is used. The descriptions in the following chapters assume that such a network interface card (NIC) is installed. The latest drivers for this NIC must be installed.
- Photonfocus GigE camera.
- Suitable power supply for the camera (see in the camera manual for specification) which can be ordered from your Photonfocus dealership.
- GigE cable of at least Cat 5E or 6.

Photonfocus GigE cameras can also be used under Linux.

Photonfocus GigE cameras work also with network adapters other than the Intel PRO/1000 GT. The GigE network adapter should support Jumbo frames.

Do not bend GigE cables too much. Excess stress on the cable results in transmission errors. In robots applications, the stress that is applied to the GigE cable is especially high due to the fast movement of the robot arm. For such applications, special drag chain capable cables are available.

The following list describes the connection of the camera to the PC (see in the camera manual for more information):

1. Remove the Photonfocus GigE camera from its packaging. Please make sure the following items are included with your camera:
   - Power supply connector
   - Camera body cap

   If any items are missing or damaged, please contact your dealership.
2. Connect the camera to the GigE interface of your PC with a GigE cable of at least Cat 5E or 6.

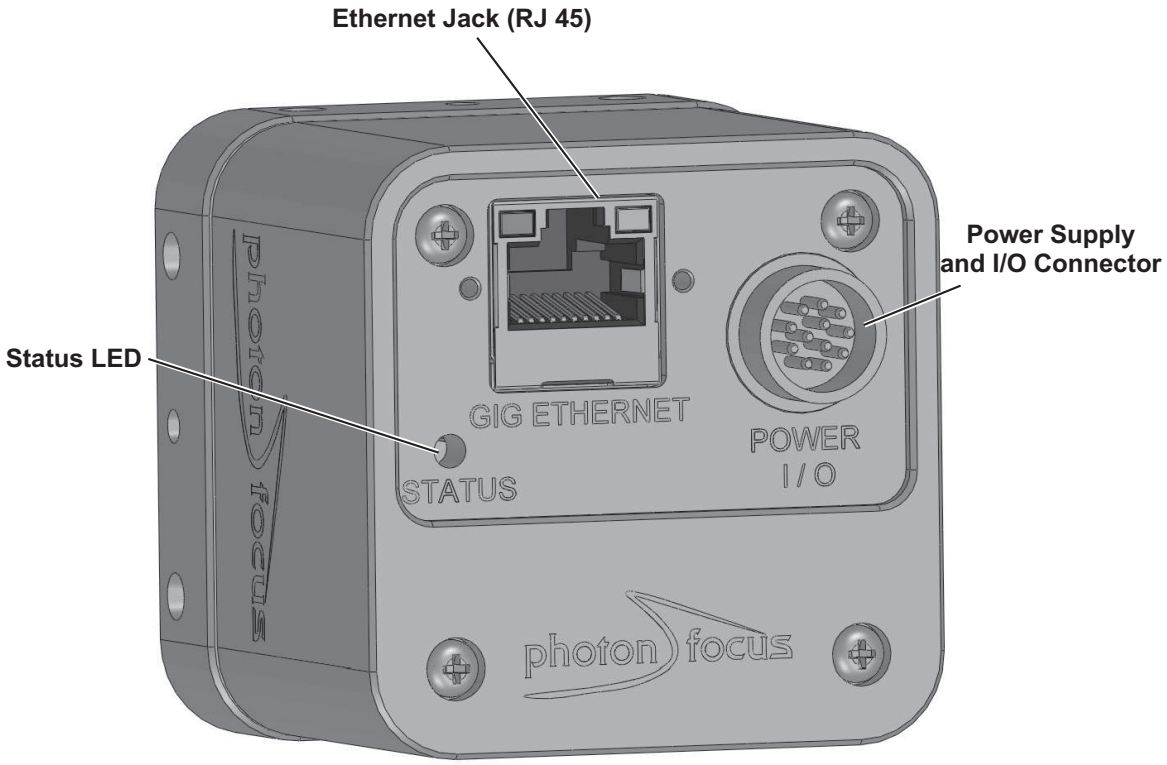

Figure 3.1: Rear view of the Photonfocus MV1-R1280 GigE camera series with power supply and I/O connector, Ethernet jack (RJ45) and status LED

3. Connect a suitable power supply to the power plug. The pin out of the connector is shown in the camera manual.

   Check the correct supply voltage and polarity! Do not exceed the operating voltage range of the camera.

   A suitable power supply can be ordered from your Photonfocus dealership.

4. Connect the power supply to the camera (see Fig. 3.1).

3.3 Software Installation

This section describes the installation of the required software to accomplish the tasks described in this chapter.

1. Install the latest drivers for your GigE network interface card.
2. Download the latest eBUS SDK installation file from the Photonfocus server.

   You can find the latest version of the eBUS SDK on the support (Software Download) page at www.photonfocus.com.

3. Install the eBUS SDK software by double-clicking on the installation file. Please follow the instructions of the installation wizard. A window might be displayed warning that the software has not passed Windows Logo testing. You can safely ignore this warning and click on `Continue Anyway`. If at the end of the installation you are asked to restart the computer, please click on `Yes` to restart the computer before proceeding.
4. After the computer has been restarted, open the eBUS Driver Installation tool (`Start -> All Programs -> eBUS SDK -> Tools -> Driver Installation Tool`) (see Fig. 3.2). If there is more than one Ethernet network card installed then select the network card where your Photonfocus GigE camera is connected. In the Action drop-down list select `Install eBUS Universal Pro Driver` and start the installation by clicking on the `Install` button. Close the eBUS Driver Installation Tool after the installation has been completed. Please restart the computer if the program asks you to do so.

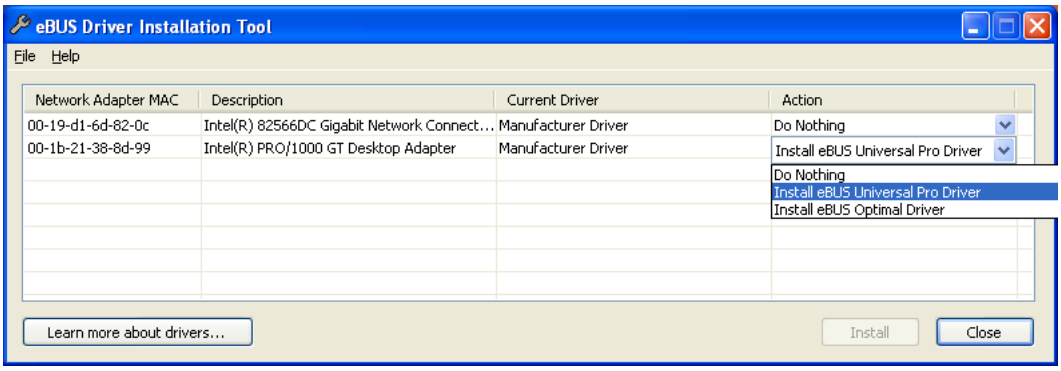

Figure 3.2: eBUS Driver Installation Tool

5. Download the latest PFInstaller from the Photonfocus server.
6. Install the PFInstaller by double-clicking on the file. In the `Select Components` (see Fig. 3.3) dialog check `PF_GEVPlayer and doc for GigE cameras`. For DR1 cameras select additionally `DR1 support and 3rd Party Tools`. For 3D cameras additionally select `PF3DSuite2 and SDK`.

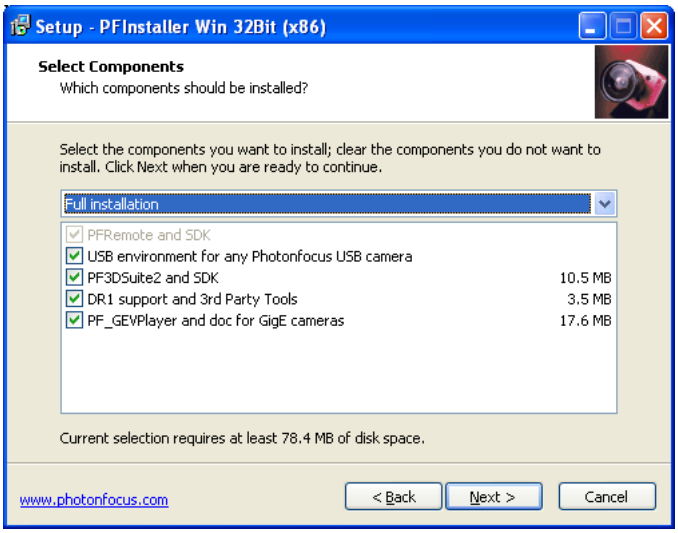
Setup - PFInstaller Win 32Bit (x86)
Select Components
Which components should be installed?
Select the components you want to install; clear the components you do not want to install. Click Next when you are ready to continue.
Full installation
PFRemote and SDK
USB environment for any Photonfocus USB camera
PF3DSuite2 and SDK 10.5 MB
DR1 support and 3rd Party Tools 3.5 MB
PF_GEVPlayer and doc for GigE cameras 17.6 MB
Current selection requires at least 78.4 MB of disk space.
www.photonfocus.com
< Back
Next >
Cancel

Figure 3.3: PFInstaller components choice

3.4 Network Adapter Configuration

This section describes recommended network adapter card (NIC) settings that enhance the performance for GigEVision. Additional tool-specific settings are described in the tool chapter.

1. Open the Network Connections window (`Control Panel -> Network and Internet Connections -> Network Connections`), right click on the name of the network adapter where the Photonfocus camera is connected and select `Properties` from the drop down menu that appears.

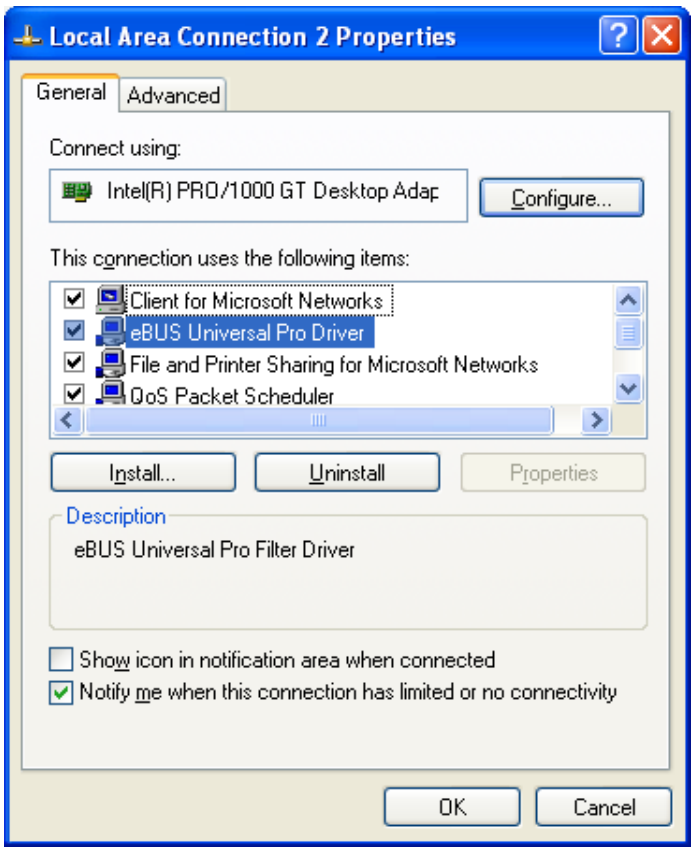

Figure 3.4: Local Area Connection Properties

2. By default, Photonfocus GigE Vision cameras are configured to obtain an IP address automatically. For this quick start guide it is recommended to configure the network adapter to obtain an IP address automatically. To do this, select `Internet Protocol (TCP/IP)` (see Fig. 3.4), click the `Properties` button and select `Obtain an IP address automatically` (see Fig. 3.5).

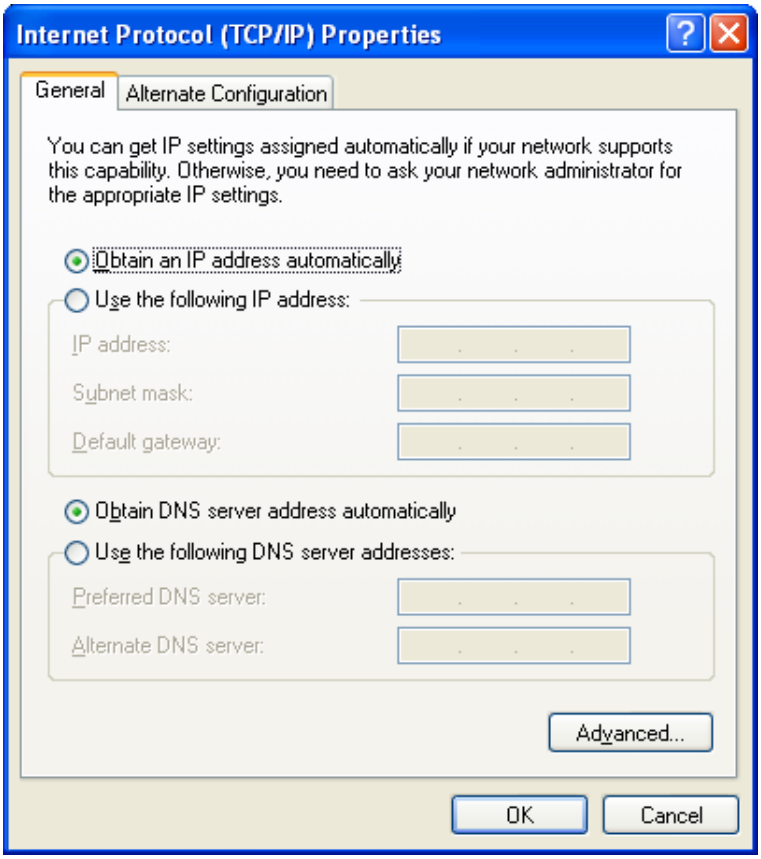
Internet Protocol (TCP/IP) Properties
General
Alternate Configuration
You can get IP settings assigned automatically if your network supports this capability. Otherwise, you need to ask your network administrator for the appropriate IP settings.
Obtain an IP address automatically
Use the following IP address:
IP address:
Subnet mask:
Default gateway:
Obtain DNS server address automatically
Use the following DNS server addresses:
Preferred DNS server:
Alternate DNS server:
Advanced...
OK
Cancel

Figure 3.5: TCP/IP Properties

3. Open again the `Local Area Connection Properties` window (see Fig. 3.4) and click on the Configure button. In the window that appears click on the `Advanced` tab and click on `Jumbo Frames` in the Settings list (see Fig. 3.6). The highest number gives the best performance. Some tools however don't support the value 16128. For this guide it is recommended to select `9014 Bytes` in the Value list.

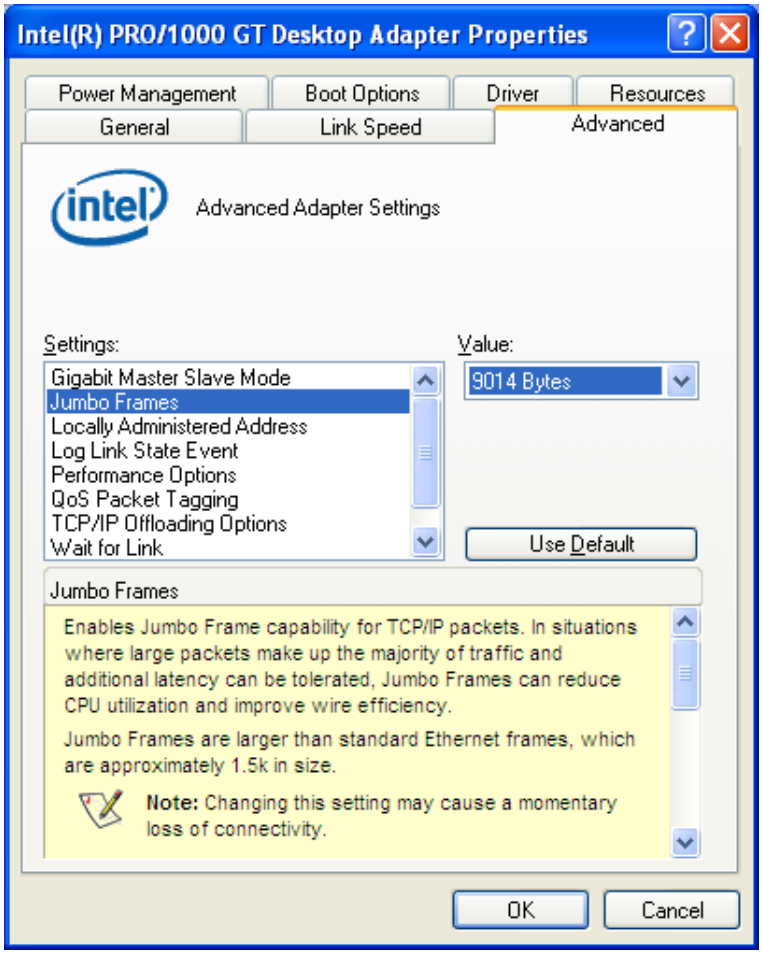
Intel(R) PRO/1000 GT Desktop Adapter Properties
Power Management
Boot Options
Driver
Resources
General
Link Speed
Advanced
Advanced Adapter Settings
Settings:
Value:
Gigabit Master Slave Mode
Jumbo Frames
Locally Administered Address
Log Link State Event
Performance Options
QoS Packet Tagging
TCP/IP Offloading Options
Wait for Link
9014 Bytes
Use Default
Jumbo Frames
Enables Jumbo Frame capability for TCP/IP packets. In situations where large packets make up the majority of traffic and additional latency can be tolerated, Jumbo Frames can reduce CPU utilization and improve wire efficiency.
Jumbo Frames are larger than standard Ethernet frames, which are approximately 1.5k in size.
Note: Changing this setting may cause a momentary loss of connectivity.
OK
Cancel

Figure 3.6: Advanced Network Adapter Properties

4. No firewall should be active on the network adapter where the Photonfocus GigE camera is connected. If the Windows Firewall is used then it can be switched off like this: Open the Windows Firewall configuration (`Start -> Control Panel -> Network and Internet Connections -> Windows Firewall`) and click on the Advanced tab. Uncheck the network where your camera is connected in the `Network Connection Settings` (see Fig. 3.7).

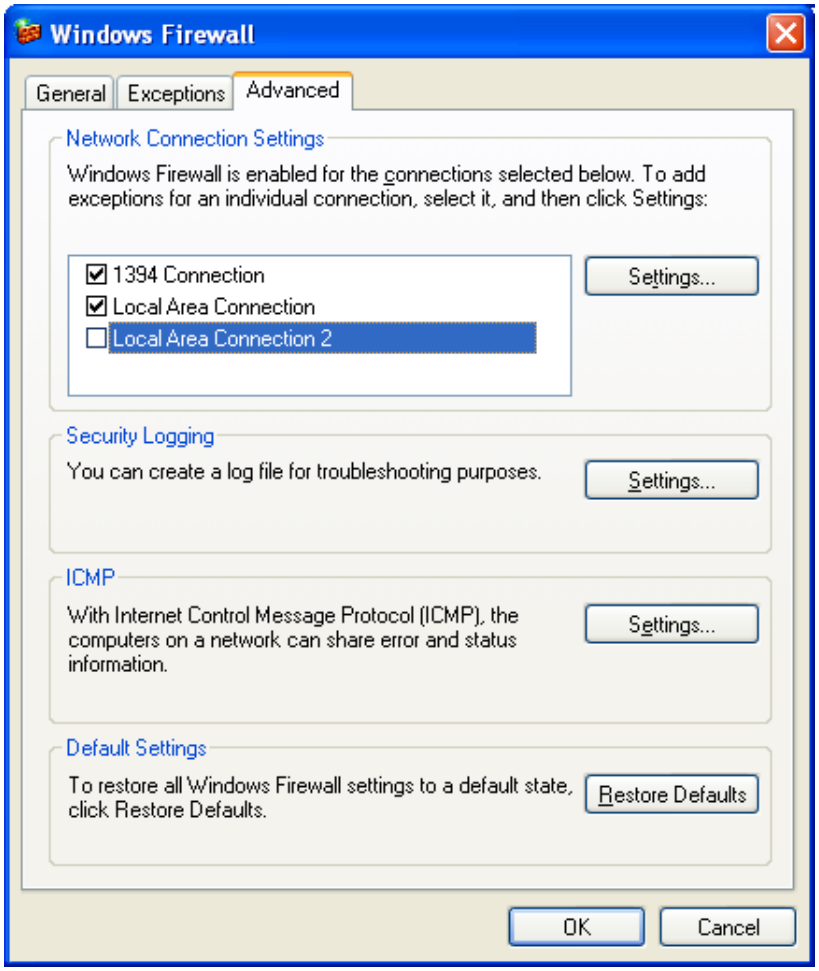
Windows Firewall
General
Exceptions
Advanced
Network Connection Settings
Windows Firewall is enabled for the connections selected below. To add exceptions for an individual connection, select it, and then click Settings:
1394 Connection
Local Area Connection
Local Area Connection 2
Settings...
Security Logging
You can create a log file for troubleshooting purposes.
Settings...
ICMP
With Internet Control Message Protocol (ICMP), the computers on a network can share error and status information.
Settings...
Default Settings
To restore all Windows Firewall settings to a default state, click Restore Defaults.
Restore Defaults
OK
Cancel

Figure 3.7: Windows Firewall Configuration

3.5 Network Adapter Configuration for Pleora eBUS SDK

Open the Network Connections window (`Control Panel -> Network and Internet Connections -> Network Connections`), right click on the name of the network adapter where the Photonfocus camera is connected and select `Properties` from the drop down menu that appears. A Properties window will open. Check the `eBUS Universal Pro Driver` (see Fig. 3.8) for maximal performance. Recommended settings for the Network Adapter Card are described in Section 3.4.

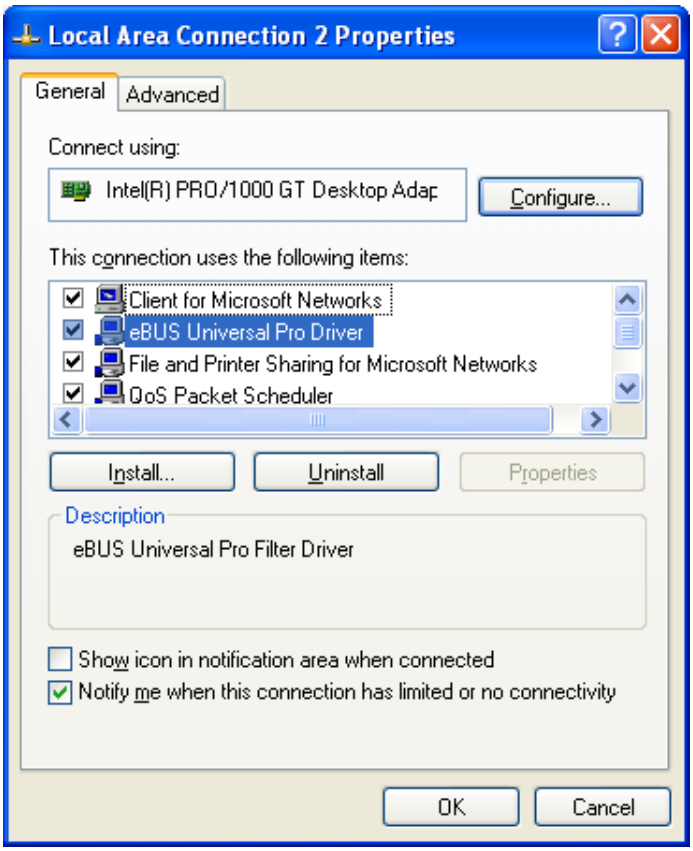

Figure 3.8: Local Area Connection Properties

3.6 Getting started

This section describes how to acquire images from the camera and how to modify camera settings.

1. Open the PF_GEVPlayer software (Start -> All Programs -> Photonfocus -> GigE_Tools -> PF_GEVPlayer) which is a GUI to set camera parameters and to see the grabbed images (see Fig. 3.9).

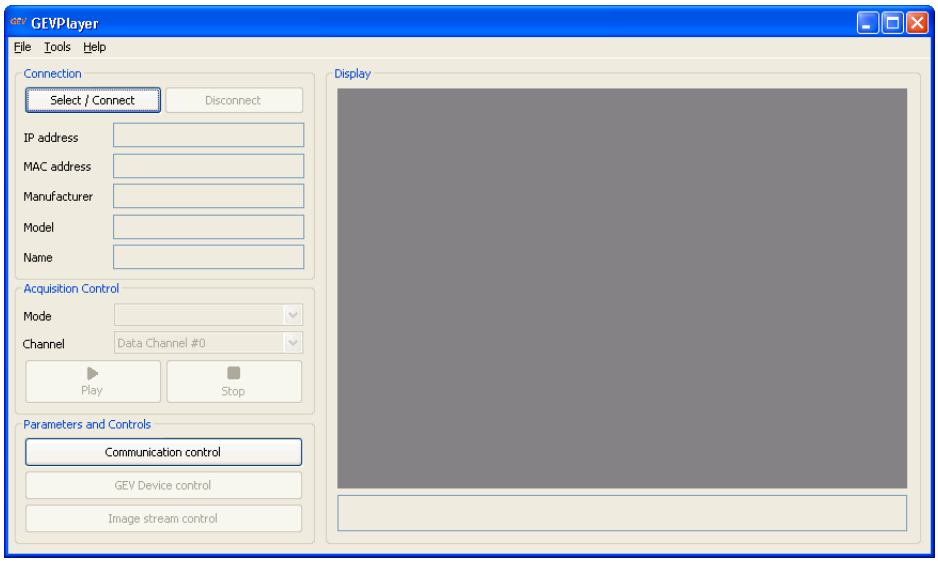

Figure 3.9: PF_GEVPlayer start screen

2. Click on the `Select / Connect` button in the PF_GEVPlayer . A window with all detected devices appears (see Fig. 3.10). If your camera is not listed then select the box `Show unreachable GigE Vision Devices`.

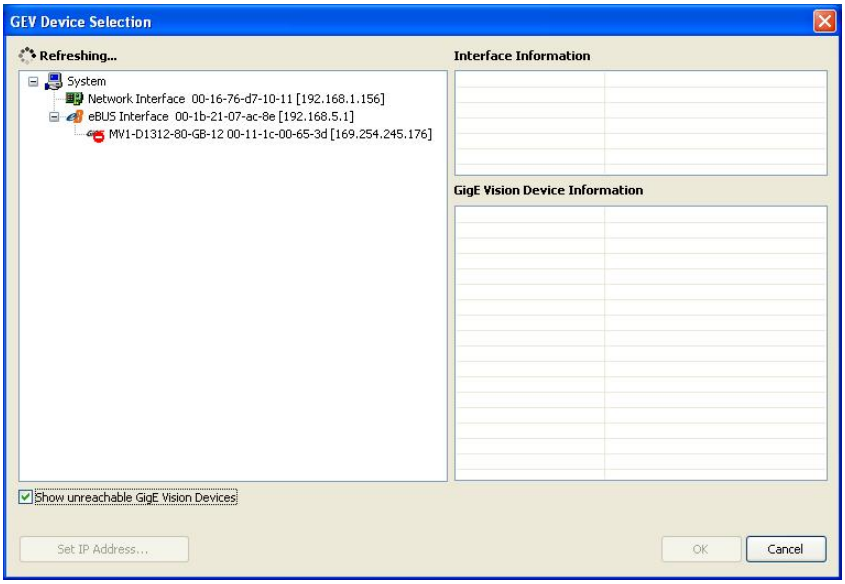

Figure 3.10: GEV Device Selection Procedure displaying the selected camera

3. Select camera model to configure and click on `Set IP Address...`.

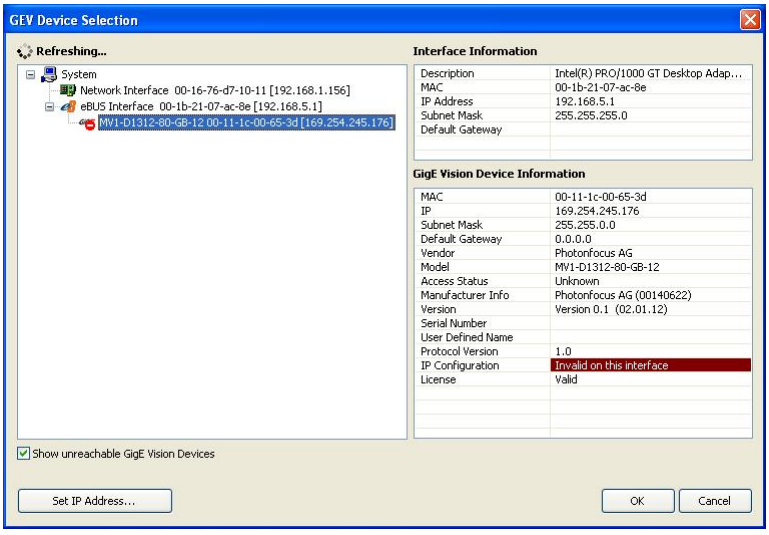

Figure 3.11: GEV Device Selection Procedure displaying GigE Vision Device Information

4. Select a valid IP address for selected camera (see Fig. 3.12). There should be no exclamation mark on the right side of the IP address. Click on `Ok` in the `Set IP Address` dialog. Select the camera in the `GEV Device Selection` dialog and click on `Ok`.

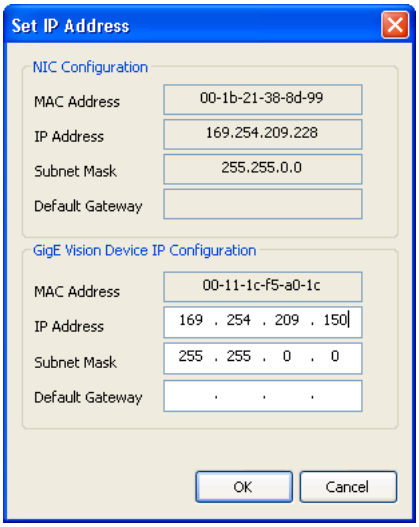

Figure 3.12: Setting IP address

5. Finish the configuration process and connect the camera to PF_GEVPlayer .

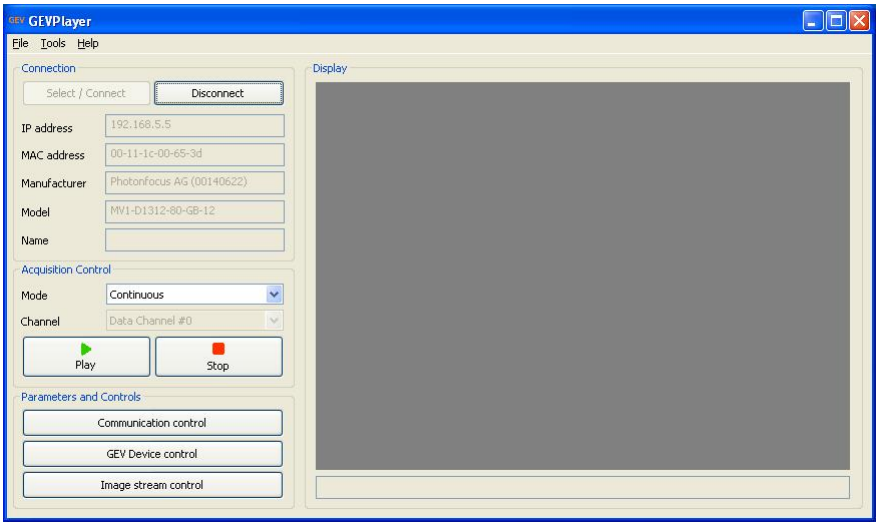

Figure 3.13: PF_GEVPlayer is readily configured

6. The camera is now connected to the PF_GEVPlayer. Click on the `Play` button to grab images.

An additional check box `DR1` appears for DR1 cameras. The camera is in double rate mode if this check box is checked. The demodulation is done in the PF_GEVPlayer software. If the check box is not checked, then the camera outputs an unmodulated image and the frame rate will be lower than in double rate mode.

If no images can be grabbed, close the PF_GEVPlayer and adjust the Jumbo Frame parameter (see Section 3.3) to a lower value and try again.

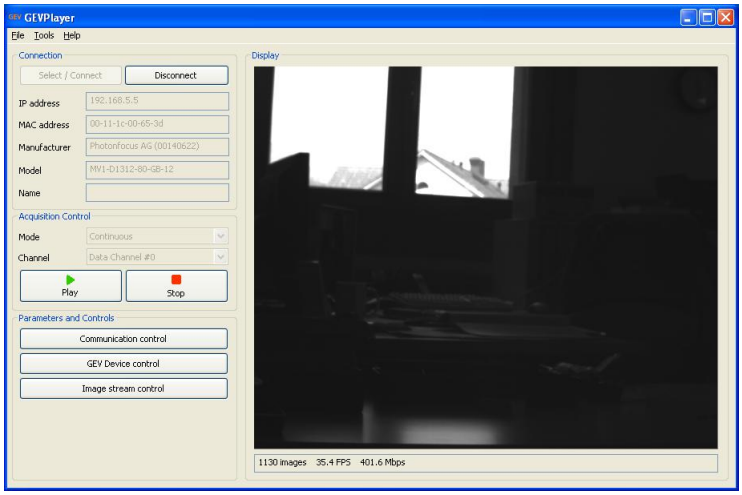

Figure 3.14: PF_GEVPlayer displaying live image stream

7. Check the status LED on the rear of the camera.

   The status LED light is green when an image is being acquired, and it is red when serial communication is active.

8. Camera parameters can be modified by clicking on `GEV Device control` (see Fig. 3.15). The visibility option Beginner shows most the basic parameters and hides the more advanced parameters. If you don't have previous experience with Photonfocus GigE cameras, it is recommended to use `Beginner` level.

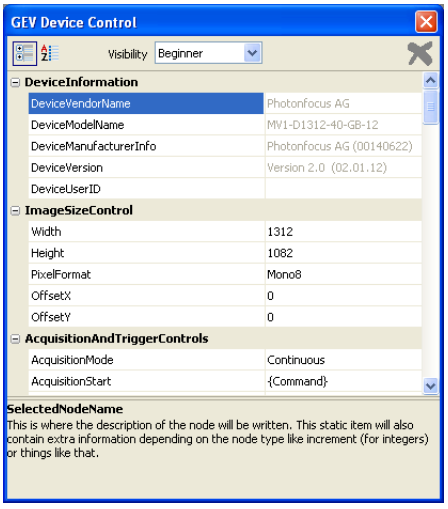

Figure 3.15: Control settings on the camera

9. To modify the exposure time scroll down to the `AcquisitionControl` control category (bold title) and modify the value of the `ExposureTime` property.

4 Product Specification

4.1 Introduction

The Photonfocus MV1-R1280 GigE camera is built around an ultra-low noise CMOS image sensor with a high dynamic range. The camera is targeted at demanding ultra-low light scientific applications and high-end night vision systems.

The principal advantages are:

- Resolution of 1280x1024 pixels
- Optimized for ultra-low light conditions
- Very low noise of less than 1 e^-
- Output greyscale resolution of up to 16 bit; internal resolution of 18 bit.
- Spectral range: 350 - 930 nm
- Rolling Shutter
- Gigabit Ethernet interface, GigE Vision and GenICam compliant
- Frame rate: 33 fps at full resolution
- Advanced I/O capabilities: 2 isolated trigger inputs, 2 differential isolated RS-422 inputs and 2 isolated outputs.
- Crosshairs overlay on the image
- Image information and camera settings inside the image (status line)
- Software provided for setting and storage of camera parameters
- The rugged housing at a compact size of 55 x 55 x 57 mm^3 makes the Photonfocus MV1-R1280 GigE camera series the perfect solution for applications in which space is at a premium.
- Programmable Logic Controller (PLC) for powerful operations on input and output signals.
- A/B RS-422 shaft encoder interface
- Wide power input range from 12 V (-10 %) to 24V (+10 %).

The general specification and features of the camera are listed in the following sections.

Figure 4.1: Photonfocus MV1-R1280 GigE camera series with C-mount lens.

4.2 Feature Overview

The general specification and features of the camera are listed in the following sections. The detailed description of the camera features is given in Chapter 5.

Characteristics	Photonfocus MV1-R1280 GigE Camera Series
Interface	Gigabit Ethernet, GigE Vision and GenICam compliant
Camera Control	GigE Vision Suite
Trigger Modes	Software Trigger / External isolated trigger input / PLC Trigger
Image pre-processing	Hotpixel correction
Features	Optimized for ultra-low light applications, Very low noise of less than $1e^-$
Features	Output greyscale resolution of up to 16 bit; internal resolution of 18 bit
	Configurable region of interest (ROI)
	Constant frame rate independent of exposure time
	Crosshairs overlay on the image
	Test pattern (LFSR and grey level ramp)
	Temperature monitoring of camera
	Camera informations readable over SDK
	Image information and camera settings inside the image (status line)
	2 isolated trigger inputs, 2 differential isolated RS-422 inputs and 2 isolated outputs

Table 4.1: Feature overview (see Chapter 5 for more information).

4.3 Available Camera Models

Please check the availability of a specific camera model on our website www.photonfocus.com.

Name	Resolution	FPS	Color
MV1-R1280-50-G2-16	1280 x 1024	33 fps [1)]	no

Table 4.2: Available Photonfocus MV1-R1280 GigE camera models (Footnotes: [1)] frame rate at at full resolution)

4.4 Technical Specification

	MV1-R1280-CL
Sensor	Ultra-low light CMOS sensor
Technology	CMOS
Optical format / diagonal	2/3" (11.7 mm diagonal)
Resolution	1280 x 1024 pixels
Pixel size	7.1 μm x 7.1 μm
Active optical area	9.1 mm x 7.3 mm
Dark current	10 e^-/s
Read out noise	1e^-
Full well capacity / SNR	13 ke^- / 114:1
Spectral range	< 380 to 940 nm (to 10 % of peak responsivity)
Responsivity	2130 x 10^3 DN / (J/m^2) @ 570 nm / 8 bit
Quantum Efficiency	> 75 %
Optical fill factor	75 %
Dynamic range	82 dB
Characteristic curve	Linear
Shutter mode	Rolling shutter
Interface	GigE Vision
Maximal Frame rate [1)]	33 fps
Camera pixel formats	8Bit / 10Bit / 12Bit / 16Bit
Fixed Pattern Noise (FPN)	< 1DN RMS @ 8bit
Exposure Time	58 μs ... 335 ms
Analog Gain	n/a
Digital Gain	0.1 to 15.99 (FineGain), up to 2048x
Micro lenses	No
Sensor bit depth	18 bit

Table 4.3: General specification of the Photonfocus MV1-R1280 GigE camera series (Footnotes: [1)] at full resolution)

	MV1-R1280 GigE
Operating temperature / moisture	0°C ... 50°C / 20 ... 80 %
Storage temperature / moisture	-25°C ... 60°C / 20 ... 95 %
Camera power supply	+12 V DC (- 10 %) ... +24 V DC (+ 10 %)
Trigger signal input range	+5 .. +30 V DC
Power consumption	< 4.4 W
Lens mount	C-Mount, CS-Mount (optional)
I/O Inputs	2x Opto-isolated, 2x RS-422 Opto-isolated
I/O Outputs	2x Opto-isolated
Dimensions	55 x 55 x 57 mm^3
Mass	285 g
Connector I/O (Power)	Hirose 12-pole (mating plug HR10A-10P-12S)
Connector Interface	RJ-45
Conformity	CE / RoHS / WEEE
IP Code	IP20

Table 4.4: Physical characteristics and operating ranges

Fig. 4.2 shows the quantum efficiency curve of the monochrome ultra-low light sensor of the MV1-R1280 camera.

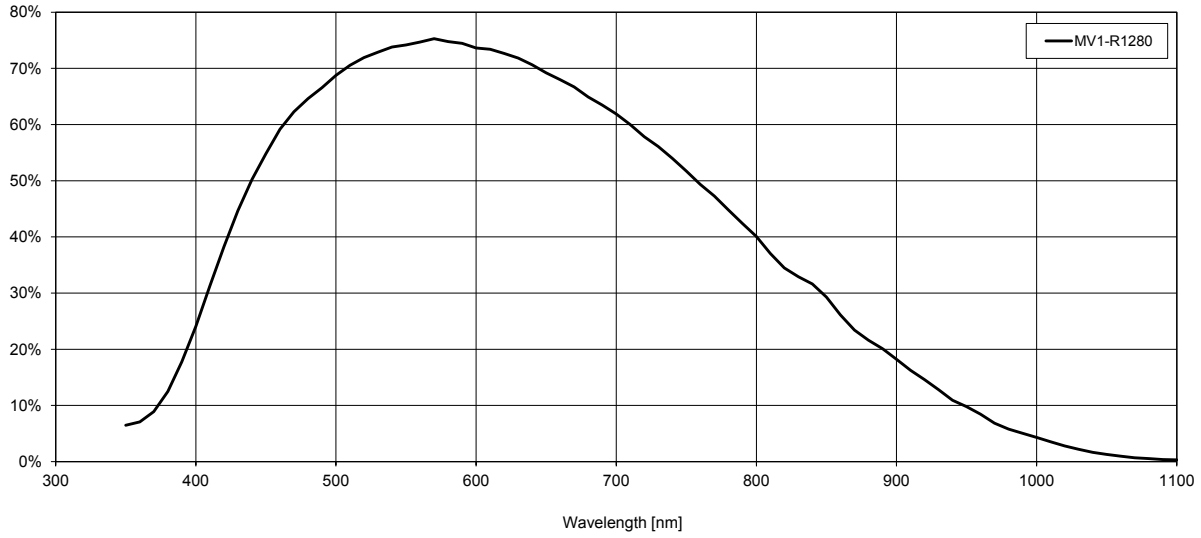

Figure 4.2: Spectral response of the ultra-low light sensor of the MV1-R1280 camera

5 Functionality

This chapter serves as an overview of the camera configuration modes and explains camera features. The goal is to describe what can be done with the camera. The setup of the cameras is explained in later chapters.

5.1 Reduction of Image Size

5.1.1 Region of Interest (ROI)

Some applications do not need full image resolution. By reducing the image size to a certain region of interest (ROI), the frame rate can be increased. A region of interest can be almost any rectangular window and is specified by its position within the full frame and its width (W) and height (H).

The ROI width must be a multiple of 2.

When the vertical ROI parameters (OffsetY, Height) are modified, the camera stops sending image for a time that is at most equal to the length of 3 full frames. Triggers that are sent during this time are ignored.

A list of common image dimension and its frame rates is shown in Table 5.1. There is a frame rate calculator in the support section of the Photonfocus web page www.photonfocus.com.

ROI Dimension	MV1-R1280-50 GigE
1280 x 1024	33 fps
1280 x 768 (WXGA)	45 fps
800 x 600 (SVGA)	57 fps
640 x 480 (VGA)	72 fps
1024 x 1024	33 fps
640 x 640	54 fps
512 x 512	67 fps
256 x 256	135 fps
1280 x 1	11570 fps

Table 5.1: Frame rates of different ROI settings (minimal exposure time)

5.1.2 Maximal Frame Rate

The maximal frame rate of the camera depends on the camera settings. The following factors influence the maximal frame rate (see also Table 5.1):

- The length of the exposure time: A shorter exposure time can lead to an increase in the maximal frame rate.
- ROI height: a smaller height ROI can lead to an increase in the maximal frame rate.

The maximal frame rate of the camera can be determined by a frame rate calculator in the support section of the Photonfocus web page www.photonfocus.com. The maximal frame rate with the current camera settings can be read out by the camera register `AcquisitionFrameRateMax` in PF_GEVPlayer or with the SDK.

To avoid a sensor artifact, the exposure must start at a fixed position from the start of the read out of one row. Therefore the exposure start must be delayed by a time TExpDel which can be as long as the read out of one row.

Exposure time < read out time

When the exposure time is smaller than the read out time then the maximal frame rate depends only on the height of the ROI (see Fig. 5.1).

MaxFrameRate = 1 / ReadoutTime

ReadoutTime = h * 28.8 μs

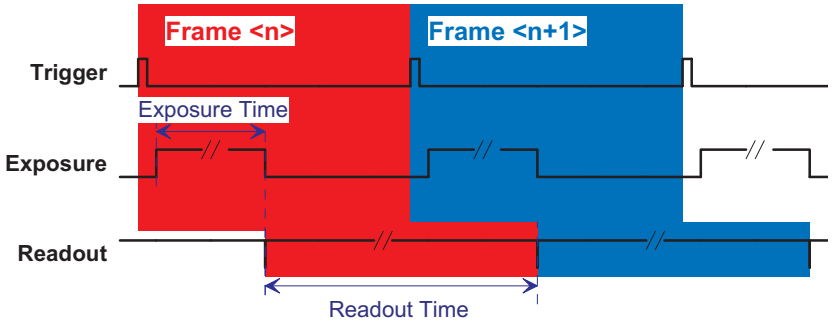

Figure 5.1: Read out timing 1: exposure time smaller than read out time

Exposure time >= read out time

When the exposure time is equal or bigger than the read out time then the maximal frame rate depends only on the exposure time (see Fig. 5.2).

MaxFrameRate = 1 / ExposureTime

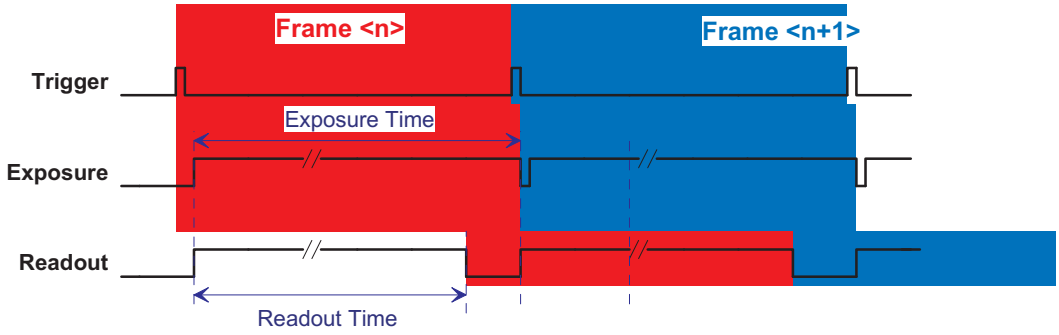

Figure 5.2: Read out timing 2: exposure time equal or bigger than read out time

5.2 Trigger and Strobe

5.2.1 Introduction

The start of the exposure of the camera's image sensor is controlled by the trigger. The trigger can either be generated internally by the camera (TriggerMode=Off / free running trigger mode) or by an external device (TriggerMode=On / external trigger mode).

This section refers to the external trigger mode if not otherwise specified.

In external trigger mode, the trigger can be applied through the power supply connector of the camera or through a software command (see Section 5.2.2). The trigger signal can be configured to be active high or active low. When the frequency of the incoming triggers is higher than the maximal frame rate of the current camera settings, then some trigger pulses will be missed. A missed trigger counter counts these events. This counter can be read out by the user.

The exposure time in external trigger mode can be defined by the setting of the exposure time register (camera controlled exposure mode) or by the width of the incoming trigger pulse (trigger controlled exposure mode) (see Section 5.2.4).

An external trigger pulse starts the exposure of one image. In Burst Trigger Mode however, a trigger pulse starts the exposure of a user defined number of images (see Section 5.2.7).

The start of the exposure is shortly after the active edge of the incoming trigger. An additional trigger delay can be applied that delays the start of the exposure by a user defined time (see Section 5.2.5). This often used to start the exposure after the trigger to a flash lighting source.

5.2.2 Trigger Source

The trigger signal can be configured to be active high or active low by the `TriggerActivation` (category `AcquisitionControl`) property. One of the following trigger sources can be used:

Free running The trigger is generated internally by the camera. Exposure starts immediately after the camera is ready and the maximal possible frame rate is attained, if `AcquisitionFrameRateEnable` is disabled. Settings for free running trigger mode:

TriggerMode = Off. In Constant Frame Rate mode (AcquisitionFrameRateEnable = True), exposure starts after a user-specified time has elapsed from the previous exposure start so that the resulting frame rate is equal to the value of AcquisitionFrameRate.

Software Trigger The trigger signal is applied through a software command (TriggerSoftware in category AcquisitionControl). Settings for Software Trigger mode: TriggerMode = On and TriggerSource = Software.

Line1 Trigger The trigger signal is applied directly to the camera by the power supply connector through pin ISO_IN1 (see also Section A.1). A setup of this mode is shown in Fig. 5.3 and Fig. 5.4. The electrical interface of the trigger input and the strobe output is described in Section 6.5. Settings for Line1 Trigger mode: TriggerMode = On and TriggerSource = Line1.

PLC_Q4 Trigger The trigger signal is applied by the Q4 output of the PLC (see also Section 6.6). Settings for PLC_Q4 Trigger mode: TriggerMode = On and TriggerSource = PLC_Q4.

ABTrigger Trigger from incremental encoder (see Section 5.2.9). The A/B Trigger feature is not available on all camera revisions, see Appendix B for a list of available features.

☞ Some trigger signals are inverted. A schematic drawing is shown in Fig. 7.4.

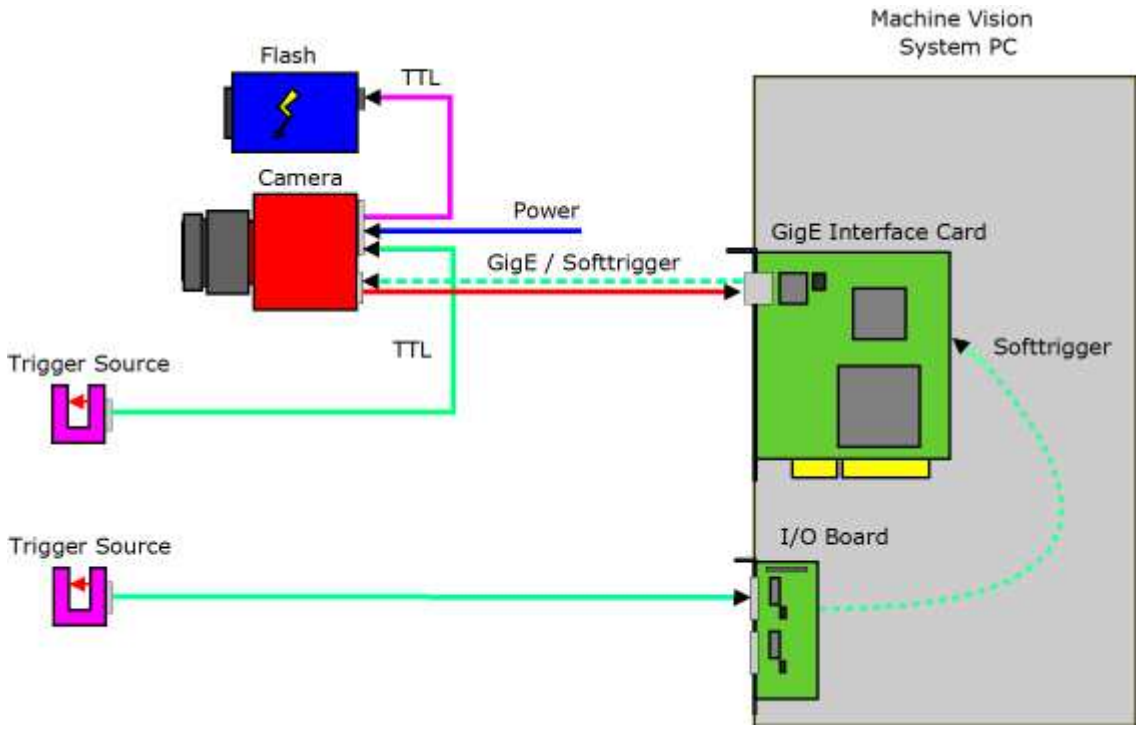

Figure 5.3: Trigger source

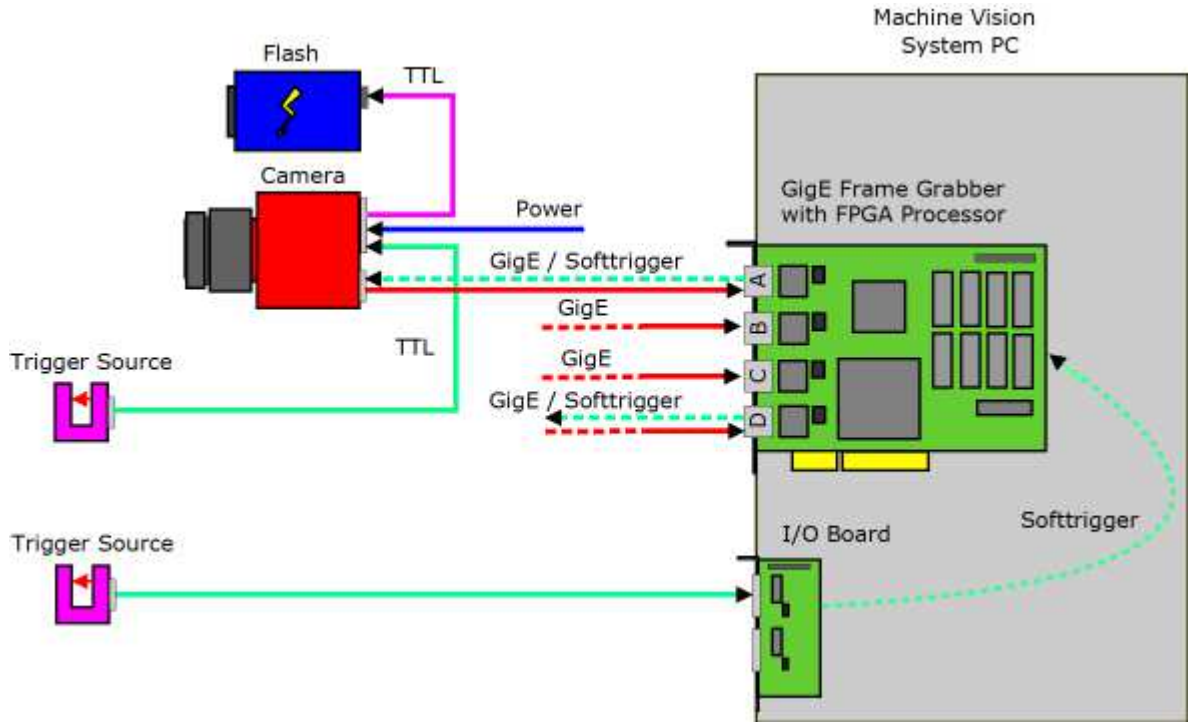

Figure 5.4: Trigger Inputs - Multiple GigE solution

5.2.3 Trigger and AcquisitionMode

The relationship between AcquisitionMode and TriggerMode is shown in Table 5.2. When `TriggerMode`=Off, then the frame rate depends on the `AcquisitionFrameRateEnable` property (see also under Free running in Section 5.2.2).

The `ContinuousRecording` and `ContinousReadout` modes can be used if more than one camera is connected to the same network and need to shoot images simultaneously. If all cameras are set to Continuous mode, then all will send the packets at same time resulting in network congestion. A better way would be to set the cameras in `ContinuousRecording` mode and save the images in the memory of the IPEngine. The images can then be claimed with `ContinousReadout` from one camera at a time avoid network collisions and congestion.

AcquisitionMode	TriggerMode	After the command AcquisitionStart is executed:
Continuous	Off	Camera is in free-running mode. Acquisition can be stopped by executing `AcquisitionStop` command.
Continuous	On	Camera is ready to accept triggers according to the `TriggerSource` property. Acquisition and trigger acceptance can be stopped by executing `AcquisitionStop` command.
SingleFrame	Off	Camera acquires one frame and acquisition stops.
SingleFrame	On	Camera is ready to accept one trigger according to the `TriggerSource` property. Acquisition and trigger acceptance is stopped after one trigger has been accepted.
MultiFrame	Off	Camera acquires n=`AcquisitionFrameCount` frames and acquisition stops.
MultiFrame	On	Camera is ready to accept n=`AcquisitionFrameCount` triggers according to the `TriggerSource` property. Acquisition and trigger acceptance is stopped after n triggers have been accepted.
SingleFrameRecording	Off	Camera saves one image on the on-board memory of the IP engine.
SingleFrameRecording	On	Camera is ready to accept one trigger according to the `TriggerSource` property. Trigger acceptance is stopped after one trigger has been accepted and image is saved on the on-board memory of the IP engine.
SingleFrameReadout	don't care	One image is acquired from the IP engine's on-board memory. The image must have been saved in the `SingleFrameRecording` mode.
ContinuousRecording	Off	Camera saves images on the on-board memory of the IP engine until the memory is full.
ContinuousRecording	On	Camera is ready to accept triggers according to the `TriggerSource` property. Images are saved on the on-board memory of the IP engine until the memory is full. The available memory is 24 MB.
ContinousReadout	don't care	All Images that have been previously saved by the `ContinuousRecording` mode are acquired from the IP engine's on-board memory.

Table 5.2: AcquisitionMode and Trigger

5.2.4 Exposure Time Control

Depending on the trigger mode, the exposure time can be determined either by the camera or by the trigger signal itself:

Camera-controlled Exposure time In this trigger mode the exposure time is defined by the camera. For an active high trigger signal, the camera starts the exposure with a positive trigger edge and stops it when the preprogrammed exposure time has elapsed. The exposure time is defined by the software.

Trigger-controlled Exposure time In this trigger mode the exposure time is defined by the pulse width of the trigger pulse. For an active high trigger signal, the camera starts the exposure with the positive edge of the trigger signal and stops it with the negative edge.

External Trigger with Camera controlled Exposure Time

In the external trigger mode with camera controlled exposure time the rising edge of the trigger pulse starts the camera states machine, which controls the sensor and optional an external strobe output. Fig. 5.5 shows the detailed timing diagram for the external trigger mode with camera controlled exposure time.

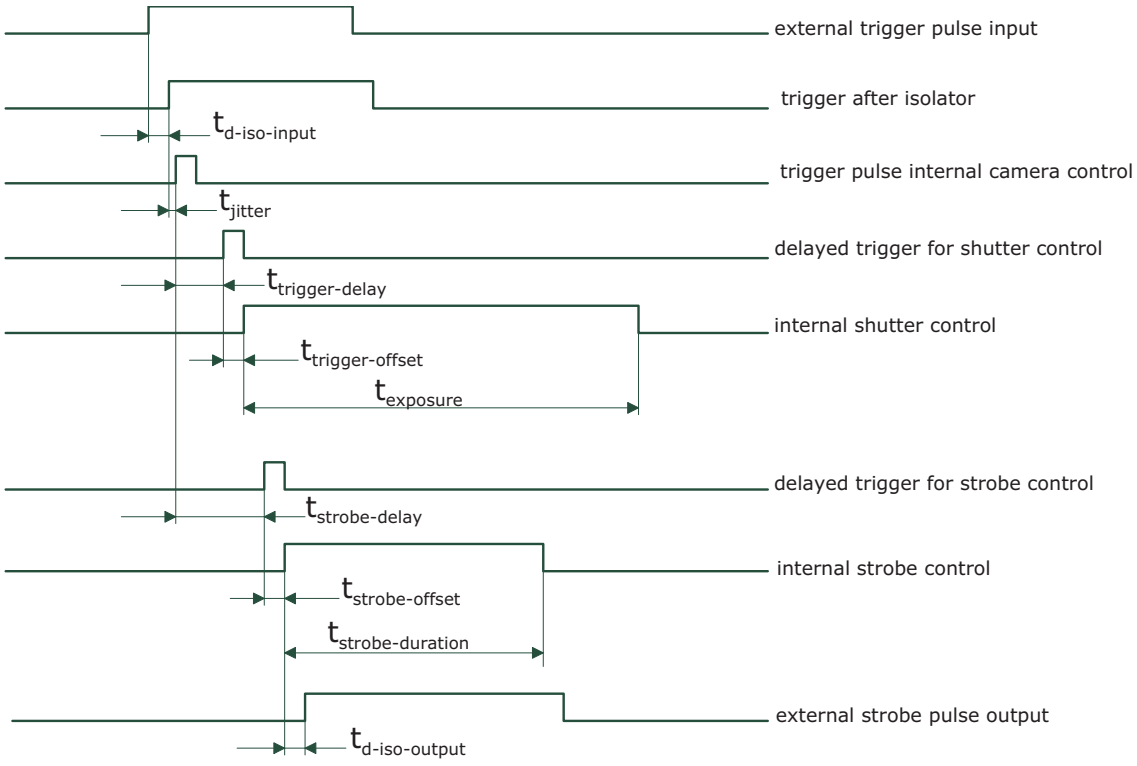

Figure 5.5: Timing diagram for the camera controlled exposure time

The rising edge of the trigger signal is detected in the camera control electronic which is implemented in an FPGA. Before the trigger signal reaches the FPGA it is isolated from the camera environment to allow robust integration of the camera into the vision system. In the signal isolator the trigger signal is delayed by time $t_{d-iso-input}$. This signal is clocked into the FPGA which leads to a jitter of t_{jitter}. The pulse can be delayed by the time $t_{trigger-delay}$ which can be configured by a user defined value via camera software. The trigger offset delay

$t_{trigger-offset}$ results then from the synchronous design of the FPGA state machines and from to requirement to start an exposure at a fixed point from the start of the read out of a row. The exposure time $t_{exposure}$ is controlled with an internal exposure time controller.

The trigger pulse from the internal camera control starts also the strobe control state machines. The strobe can be delayed by $t_{strobe-delay}$ with an internal counter which can be controlled by the customer via software settings. The strobe offset delay $t_{strobe-delay}$ results then from the synchronous design of the FPGA state machines. A second counter determines the strobe duration $t_{strobe-duration}$(strobe-duration). For a robust system design the strobe output is also isolated from the camera electronic which leads to an additional delay of $t_{d-iso-output}$ Table 5.3 gives an overview over the minimum and maximum values of the parameters.

External Trigger with Pulsewidth controlled Exposure Time

In the external trigger mode with Pulsewidth controlled exposure time the rising edge of the trigger pulse starts the camera states machine, which controls the sensor. The falling edge of the trigger pulse stops the image acquisition. Additionally the optional external strobe output is controlled by the rising edge of the trigger pulse. Timing diagram Fig. 5.6 shows the detailed timing for the external trigger mode with pulse width controlled exposure time.

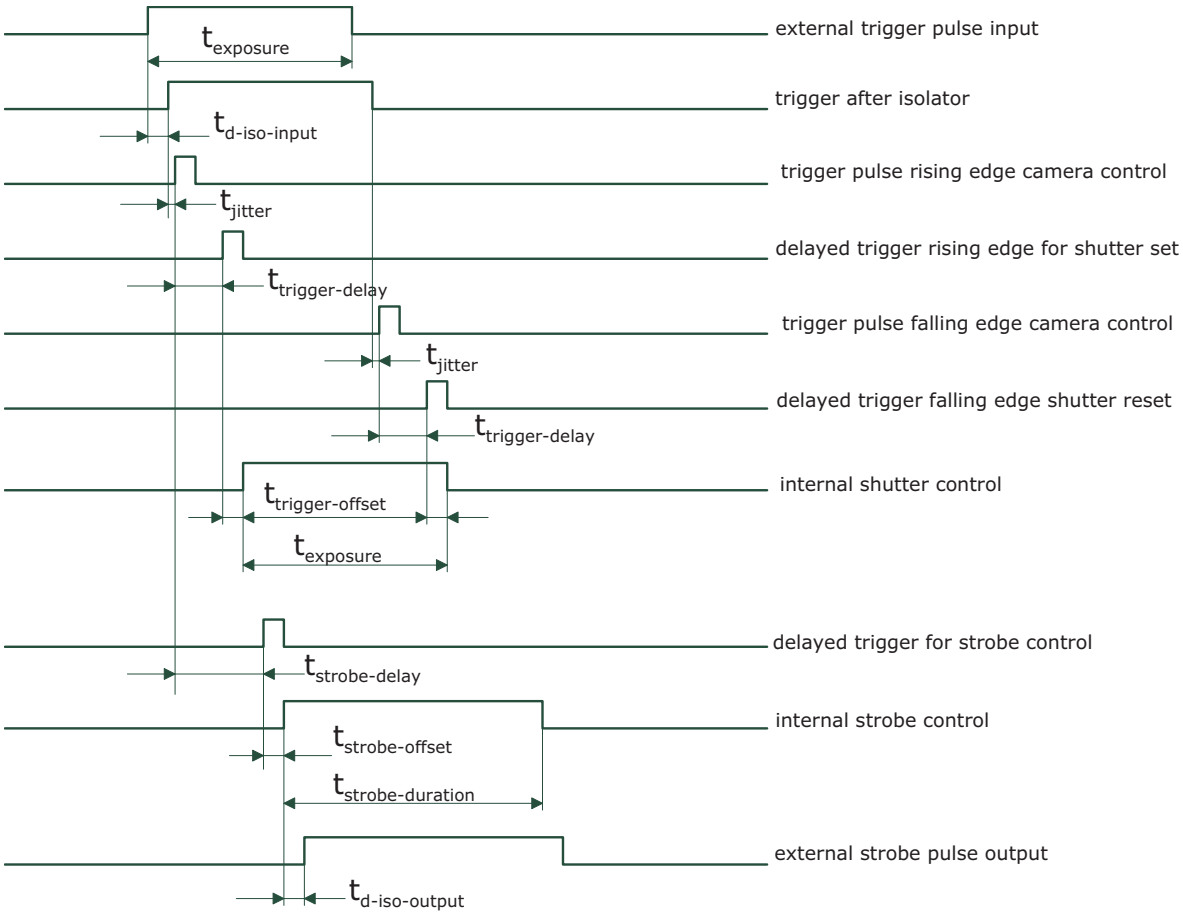

Figure 5.6: Timing diagram for the Pulsewidth controlled exposure time

The timing of the rising edge of the trigger pulse until to the start of exposure and strobe is equal to the timing of the camera controlled exposure time (see Section 5.2.4). In this mode however the end of the exposure is controlled by the falling edge of the trigger Pulsewidth:

The falling edge of the trigger pulse is delayed by the time $t_{d-iso-input}$ which results from the signal isolator. This signal is clocked into the FPGA which leads to a jitter of t_{jitter}. The pulse is then delayed by $t_{trigger-delay}$ by the user defined value which can be configured via camera software. After the trigger offset time $t_{trigger-offset}$ the exposure is stopped.

The time from the active trigger edge to the active edge of the next trigger must not be smaller than the minimal frame time (1 / MaxFrameRate) achievable with the current camera settings. Violation of this condition can result in corrupt images or the camera might stop to grab images.

5.2.5 Trigger Delay

The trigger delay is a programmable delay in milliseconds between the incoming trigger edge and the start of the exposure. This feature may be required to synchronize the external strobe with the exposure of the camera.

5.2.6 Strobe Output

The strobe output is an isolated output located on the power supply connector that can be used to trigger a strobe. The strobe output can be used both in free-running and in trigger mode. Strobe settings:

Strobe_Delay Programmable delay delay from the active input trigger edge to the rising edge of the strobe output signal.

Strobe_PulseWidth Width of the trigger pulse in μs. A setting of 0 turns off the strobe output.

Strobe_Invert Inverts the strobe output signal. Strobe_Invert=False: strobe signal active high, Strobe_Invert=True: strobe signal active low.

The strobe output needs a separate power supply. Please see Section 6.5, Fig. 5.3 and Fig. 5.4 for more information.

5.2.7 Burst Trigger

The camera includes a burst trigger engine. When enabled, it starts a predefined number of acquisitions after one single trigger pulse. The time between two acquisitions and the number of acquisitions can be configured by a user defined value via the camera software. The burst trigger feature works only in the mode "Camera controlled Exposure Time".

The burst trigger signal can be configured to be active high or active low. When the frequency of the incoming burst triggers is higher than the duration of the programmed burst sequence, then some trigger pulses will be missed. A missed burst trigger counter counts these events. This counter can be read out by the user.

The burst trigger mode is only available when `TriggerMode`=On. Trigger source is determined by the `TriggerSource` property.

The timing diagram of the burst trigger mode is shown in Fig. 5.7.

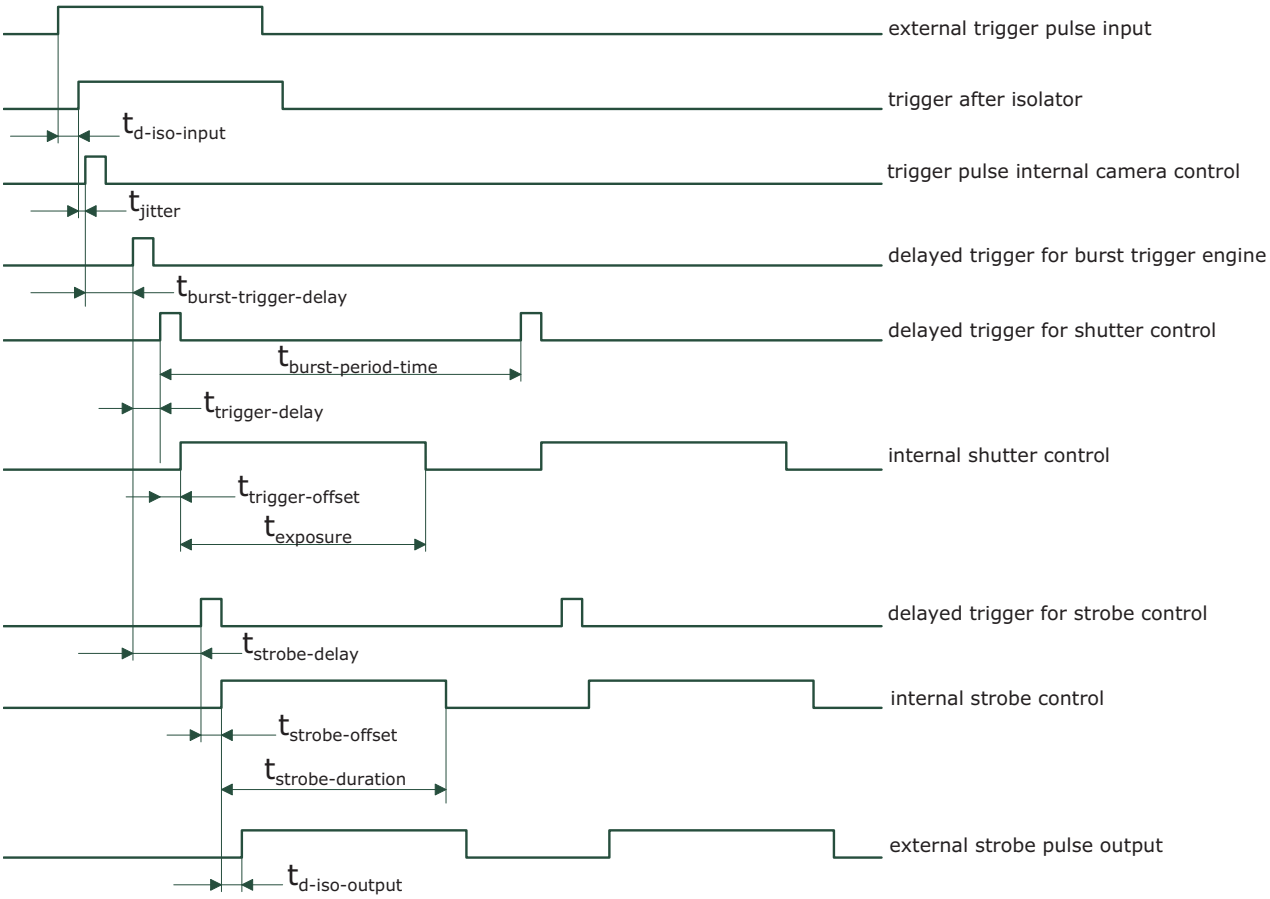

Figure 5.7: Timing diagram for the burst trigger mode

5.2.8 Trigger Timing Values

Table 5.3 shows the values of the trigger timing parameters.

	MV1-R1280-50 GigE	MV1-R1280-50 GigE
Timing Parameter	**Minimum**	**Maximum**
$t_{d-iso-input}$	1 μs	1.5 μs
$t_{d-RS422-input}$	65 ns	185 ns
t_{jitter}	0	20 ns
$t_{trigger-delay}$	0	0.33 s
$t_{burst-trigger-delay}$	0	0.33 s
$t_{burst-period-time}$	depends on camera settings	0.33 s
$t_{trigger-offset}$ (non burst mode)	200 ns	duration of 1 row
$t_{trigger-offset}$ (burst mode)	250 ns	250 ns
$t_{exposure}$	58 μs	0.33 s
$t_{strobe-delay}$	600 ns	0.33 s
$t_{strobe-offset}$ (non burst mode)	200 ns	200 ns
$t_{strobe-offset}$ (burst mode)	250 ns	250 ns
$t_{strobe-duration}$	200 ns	0.33 s
$t_{d-iso-output}$	150 ns	350 ns
$t_{trigger-pulsewidth}$	200 ns	n/a
Number of bursts n	1	30000

Table 5.3: Summary of timing parameters relevant in the external trigger mode using camera MV1-R1280-50 GigE

5.2.9 A/B Trigger for Incremental Encoder

An incremental encoder with A/B outputs can be used to synchronize the camera triggers to the speed of a conveyor belt. These A/B outputs can be directly connected to the camera and appropriate triggers are generated inside the camera.

The A/B Trigger feature is is not available on all camera revisions, see Appendix B for a list of available features.

In this setup, the output A is connected to the camera input ISO_INC0 (see also Section 6.5.4 and Section A.1) and the output B to ISO_INC1.

In the camera default settings the PLC is configured to connect the ISO_INC inputs to the A/B camera inputs. This setting is listed in Section 7.7.3.

The following parameters control the A/B Trigger feature:

TriggerSource Set TriggerSource to `ABTrigger` to enable this feature

ABMode Determines how many triggers should be generated. Available modes: single, double, quad (see description below)

ABTriggerDirection Determines in which direction a trigger should be generated: `fwd`: only forward movement generates a trigger; `bkwd`: only backward movement generates a trigger; `fwdBkwd`: forward and backward movement generate a trigger.

ABTriggerDeBounce Suppresses the generation of triggers when the A/B signal bounce. ABTriggerDeBounce is ignored when `ABTriggerDirection=fwdbkwd`.

ABTriggerDivider Specifies a division factor for the trigger pulses. Value 1 means that all internal triggers should be applied to the camera, value 2 means that every second internal trigger is applied to the camera.

EncoderPosition (read only) Counter (signed integer) that corresponds to the position of incremental encoder. The counter frequency depends on the ABMode. It counts up/down pulses independent of the `ABTriggerDirection`. Writing to this property resets the counter to 0.

A/B Mode

The property ABMode takes one of the following three values:

Single A trigger is generated on every A/B sequence (see Fig. 5.8). `TriggerFwd` is the trigger that would be applied if `ABTriggerDirection=fwd`, `TriggerBkwd` is the trigger that would be applied if `ABTriggerDirection=bkwd`, `TriggerFwdBkwd` is the trigger that would be applied if `ABTriggerDirection=fwdBkwd`. `GrayCounter` is the Gray-encoded BA signal that is shown as an aid to show direction of the A/B signals. `EncoderCounter` is the representation of the current position of the conveyor belt. This value is available as a camera register.

Double Two triggers are generated on every A/B sequence (see Fig. 5.9).

Quad Four triggers are generated on every A/B sequence (see Fig. 5.10).

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There is a bug in the single A/B trigger mode in some camera revisions (see Appendix B, A/B Trigger Bug). In this case when the encoder position moves back and forth by a small amount, the EncoderCounter is incremented and the decrement is sometimes omitted, leading to a wrong EncoderPosition indication in the camera. Therefore the single A/B trigger mode should not be used in the affected versions. To have the same behaviour as the single trigger mode, but without the bug, use the double A/B mode and double the value of `ABTriggerDivider`.

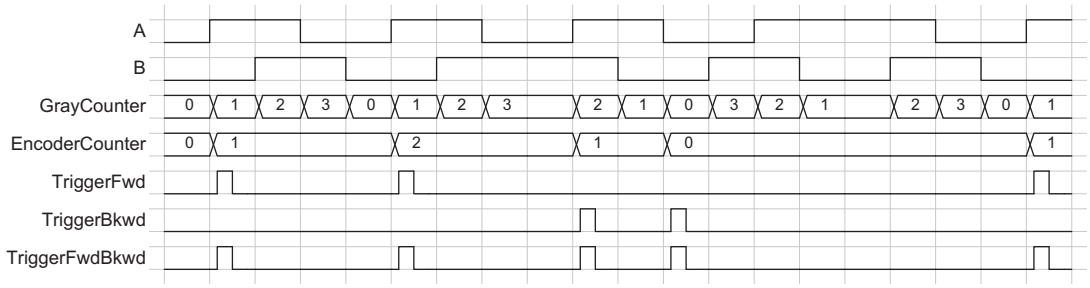

Figure 5.8: Single A/B Mode

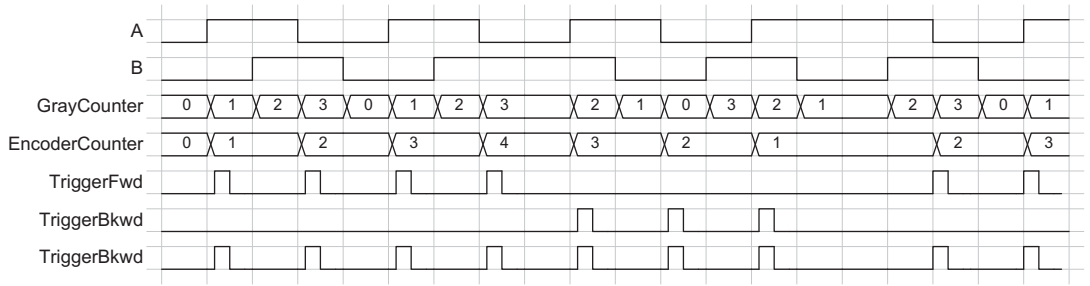

Figure 5.9: Double A/B Mode

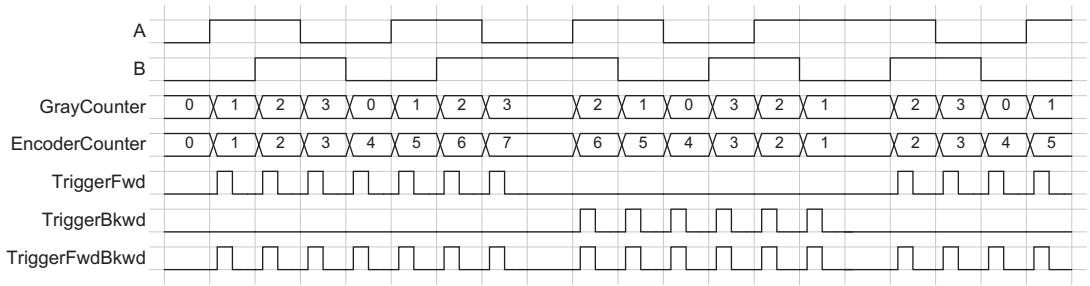

Figure 5.10: Quad A/B Mode

A/B Trigger Debounce

A debouncing logic can be enabled by setting `ABTriggerDeBounce=True`. It is implemented with a watermark value of the EncoderCounter (see Fig. 5.11). Suppose `ABTriggerDirection=fwd`, then the watermark value is increased with the increments of the EncoderCounter. If EncoderCounter decreases, e.g. Due to bouncing problems, the watermark value is hold unchanged. Triggers are then only generated when the watermark value increases.

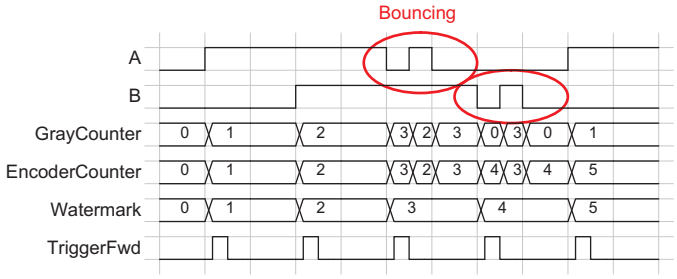

Figure 5.11: A/B Trigger Debouncing, example with ABMode=quad

The A/B Trigger Debounce mode can also be used for another issue:

In some applications the conveyor belt may stop between parts. In practice the conveyor belt stops and retraces by a small amount which may cause a misalignment in the system. If `ABTriggerDirection=fwd` is used and the Debounce mode is enabled and the conveyor belt starts again in forward direction, no triggers are generated for the amount that the conveyor belt retraced (see Fig. 5.12). The highest value of the EncoderCounter is stored as the watermark. Triggers are only generated when the EncoderCounter is at the watermark level.

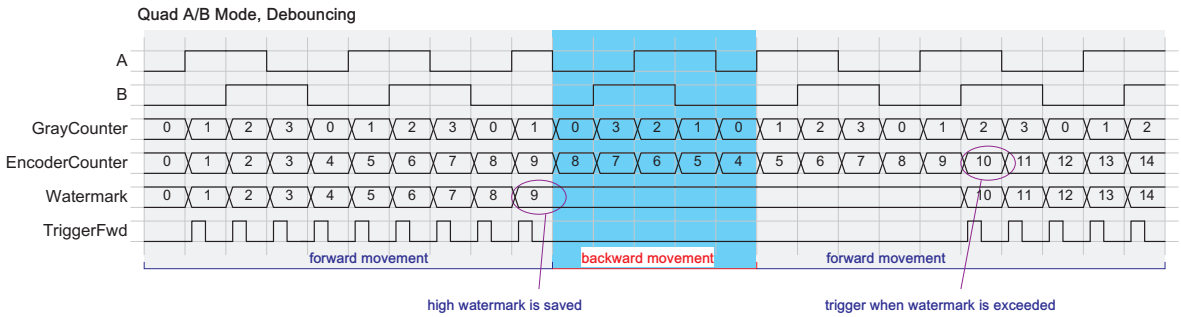

Figure 5.12: A/B Trigger Debouncing, example with ABMode=quad; example for encoder retracing

A/B Trigger Divider

if ABTriggerDivider>1 then not all internally generated triggers are applied to the camera logic. E.g. If ABTriggerDivider=2, then every second trigger is applied to the camera (see Fig. 5.13).

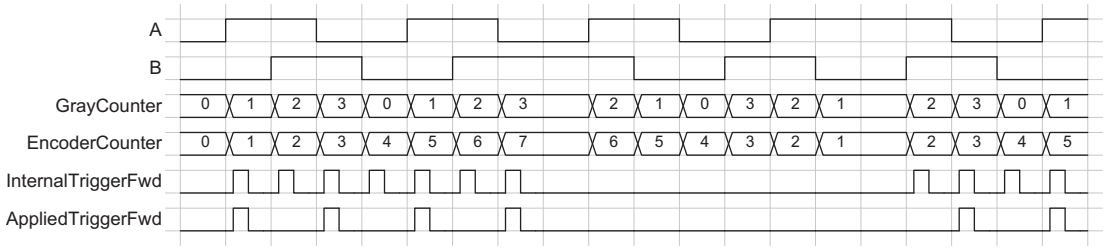

Figure 5.13: A/B Trigger Divider, example with ABTriggerDivider=1, ABMode=quad

A Only Trigger

The camera supports the use of simple incremental decoders that only provide one input, by enabling the property ABTriggerAOnly. The B-signal is ignored in this mode and information about direction of the object movement is not available: if ABTriggerAOnly is enabled then the encoder position is always incremented. Detailed diagrams are shown in Fig. 5.14 and Fig. 5.15. Note that the quad mode is not available when ABTriggerAOnly=true.

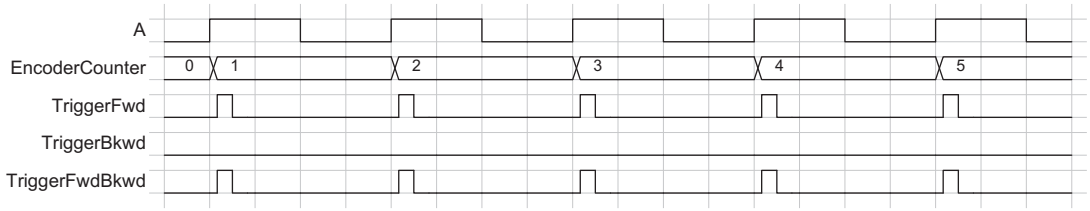

Figure 5.14: AOnly Trigger in Single A/B Mode

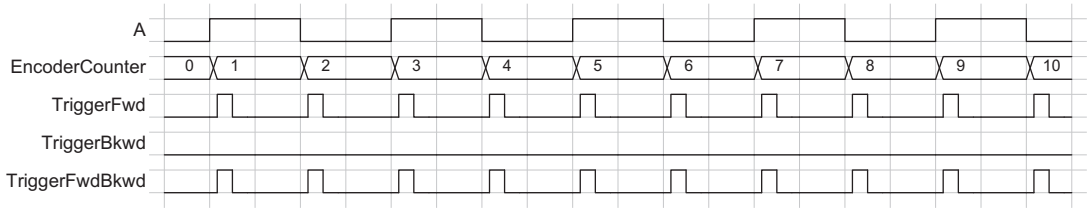

Figure 5.15: AOnly Trigger in Double A/B Mode

Encoder Position

The internal ABTrigger signal before the ABTriggerDivider is processed for the Encoder Position: every TriggerFwd pulse increments the Encoder Position and every TriggerBkwd pulse decrements its value. For details refer to the diagram of the corresponding mode.

The Encoder Position value can be accessed through the EncoderPosition property or through the status info that is inserted into the image (see Section 5.7).

By default the Encoder Position is only generated when TriggerMode=On and TriggerSource=ABTrigger. When the property ABTriggerCountAlways=True, then the Encoder Position is generated regardless of the trigger mode.

5.2.10 Missed Trigger Counters

The missed trigger counters are important tools to make sure that the frequency of an external trigger can be processed by the camera. A value bigger than 0 indicates that not all applied triggers were processed.

The missed trigger counters are reset by writing the value 0 to the counter register. The counter value can be read out by a property or it can be embedded in the camera image by the status line (see Section 5.7.2):

It is recommended to reset the missed trigger counters after modifying trigger-related settings.

Missed Trigger Counter If an external trigger (TriggerMode=On) is applied while the camera is not ready to accept a new trigger, a counter (Missed Trigger Counter) is incremented and the trigger is rejected. The value of the Missed Trigger Counter can be read out from the camera property (Counter_MissedTrigger). When the Missed Trigger Counter reaches its maximal value it will not wrap around. The user can reset the Missed Trigger Counter by writing the value 0 to Counter_MissedTrigger. In Burst Trigger Mode (see Section 5.2.7), an increment of the missed burst trigger value indicates that the burst trigger period time (Trigger_BurstTriggerPeriodTime) is too short for the applied camera settings.

Missed Burst Trigger Counter When the camera is in burst trigger mode (see Section 5.2.7), a missed burst trigger counter will be incremented, when a subsequent external trigger (TriggerMode=On) is applied while a burst sequence is running. The value of the Missed Burst Trigger Counter can be read out from the camera property (Counter_MissedBurstTrigger). When the Missed Burst Trigger Counter reaches its maximal value it will not wrap around. The user can reset the Missed Burst Trigger Counter.

5.2.11 Counter Reset by an External Signal

The image counter and the real time counter (timestamp) (see Section 5.7.1) can be reset by an external signal. Both counters can be embedded into the image by the status line (see Section 5.7) or their register can be read out. These counters may be used to check that no images are lost or to ease the synchronisation of multiple cameras.

The external signal to reset the above mentionend counters is selected by the property Counter_ResetCounterSource. Available choices are PLC_Q4 to PLC_Q7 (see Section 7.7), Line1 (ISO_IN1) and ExposureStart. ExposureStart resets the counters at the start of an exposure.

The property Counter_ResetCounterMode determines how often the selected source should reset the counters. The setting Once works together with the property Counter_ResetCounterOnNextTrigger.

If Counter_ResetCounterMode=Once, then the counters are reset on the next active edge of the selected reset source (property Counter_ResetCounterSource) after the device is armed with Counter_ResetCounterOnNextTrigger=True. The register Counter_ResetCounterOnNextTrigger is reset after the resetting trigger is received.

The setting Counter_ResetCounterMode=Continuous resets the counters on every occurrence of an active edge of the reset source without the requirement to arm the device first. This setting is suited if the reset source signal is different than the camera trigger.

The active edge of the reset input can be set by the property Counter_ResetCounterSourceInvert. If set to True, then the rising edge is the active edge, else the falling edge.

Counter reset by an external signal is important if you would like to synchronize multiple cameras. One signal is applied to all cameras which resets the counters simultaneously. The timestamps of all cameras are then theoretically synchronous with each other. In practice every camera runs on its own clock source which has a precision of +/- 30 ppm and therefore the values of the timestamp (real time counter) of the cameras may diverge with time. If this is an issue, then the counters could be reset periodically by the external signal.

The counter reset by an external signal feature might not be available on all camera revisions, see Appendix B for a list of available features.

5.2.12 Trigger Acquisition

The applied trigger can be enabled or disabled by one or two external signals in the TriggerAcquisition mode. This mode works with free-running (internal) trigger and external trigger.

The property TriggerAcquisition_Enable enables the TriggerAcquisition mode.

Level Triggered Trigger Acquisition

The Level Triggered mode is enabled by setting TriggerAcquisition_Mode to Level and TriggerAcquisition_Enable=True. A signal acts as a trigger enable (see Fig. 5.16). This signal is selected by TriggerAcquisition_StartSource. A high signal level enables triggering of the camera and a low signal level disables all triggers.

To invert the TriggerAcquisition signal use one of the PLC_Q signal and select the inverted signal as its source. Table 5.4 shows a setting that uses ISO_IN0 as trigger enable signal: the inverted signal is used as ISO_IN0 is inverted in the input logic (see Fig. 7.4).

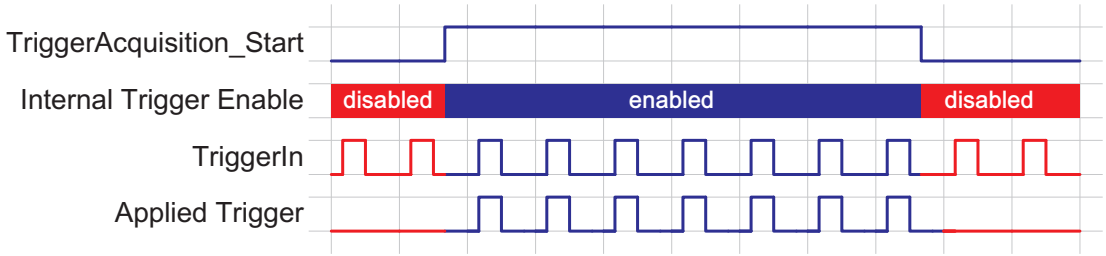

Figure 5.16: Trigger Acquisition Level triggered (TriggerAcquisition_Mode = Level)

Feature	Value	Category
TriggerAcquisition_Enable	True	Trigger/TriggerAcquisition
TriggerAcquisition_Mode	Level	Trigger/TriggerAcquisition
TriggerAcquisition_StartSource	PLC_Q5	Trigger/TriggerAcquisition
PLC_I0	Line0	<PLC>/SignalRoutingBlock
PLC_Q5_Variable0	PLC_I0_Not	<PLC>/LookupTable/Q5
PLC_Q5_Operator0	Or	<PLC>/LookupTable/Q5
PLC_Q5_Variable1	Zero	<PLC>/LookupTable/Q5
PLC_Q5_Operator1	Or	<PLC>/LookupTable/Q5
PLC_Q5_Variable2	Zero	<PLC>/LookupTable/Q5
PLC_Q5_Operator2	Or	<PLC>/LookupTable/Q5
PLC_Q5_Variable3	Zero	<PLC>/LookupTable/Q5

Table 5.4: Example of using ISO_IN0 as trigger enable in level mode

Edge Triggered Trigger Acquisition

The Edge Triggered mode is enabled by setting `TriggerAcquisition_Mode` to `Edge` and `TriggerAcquisition_Enable=True`. Two signals act as trigger enable (see Fig. 5.17). A rising edge on the start signal enables triggering. A rising edge on the stop signal disables all triggers. The start/stop signals are selected by `TriggerAcquisition_StartSource` and `TriggerAcquisition_StopSource`.

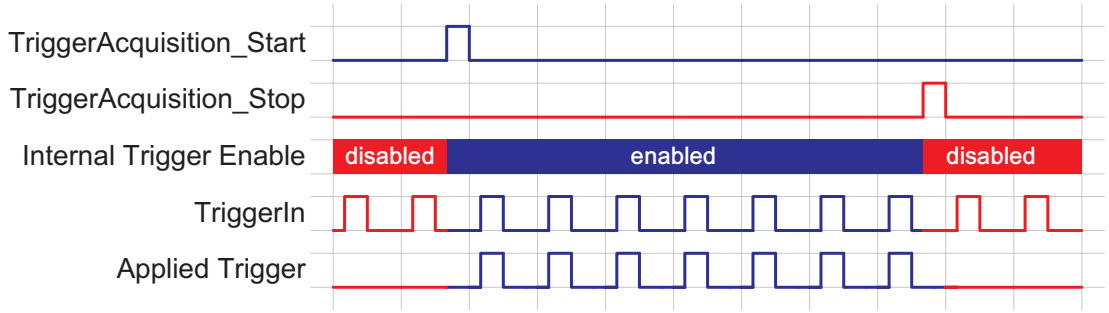

Figure 5.17: Trigger Acquisition Level triggered (TriggerAcquisition_Mode = Edge)

Trigger Acquisition and Free-Running Trigger

The `TriggerAcquisition` feature can also be used with free-running trigger (`TriggerMode=Off`). `TriggerAcquisition` enables or disables in this case the generation of the free-running trigger.

5.3 Data Path Overview

The data path is the path of the image from the output of the image sensor to the output of the camera. The sequence of blocks is shown in figure Fig. 5.18.

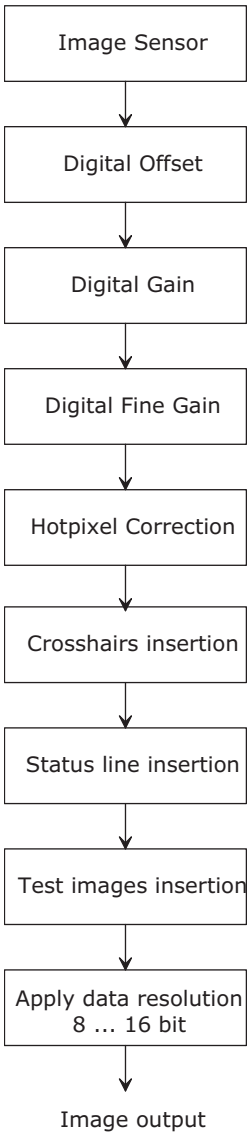

Figure 5.18: camera data path

5.4 Gain and Offset

There are two different gain settings on the camera:

Gain (Digital Fine Gain) Digital fine gain accepts fractional values from 0.01 up to 15.99. It is implemented as a multiplication operation.

Digital Gain Digital Gain is a coarse gain with the settings x1, x2, ..., x2048. It is implemented as a binary shift of the image data where the two LSB from the image sensor and '0' are shifted to the LSB's of the gray values. E.g. for gain x2, the output value is shifted by 1 and bit 0 is set to sensor LSB bit 1.

The resulting gain is the product of the two gain values, which means that the image data is multiplied in the camera by this factor.

Digital Fine Gain and Digital Gain may result in missing codes in the output image data.

A user-defined value can be subtracted from the gray value in the digital offset block. If digital gain is applied and if the brightness of the image is too big then the interesting part of the output image might be saturated. By subtracting an offset from the input of the gain block it is possible to avoid the saturation.

5.5 Hotpixel Correction

Image noise is amplified when operating at high gain values. In this case some pixels appear as very bright pixels. There is a hotpixel correction that corrects this issue.

The hotpixel correction compares the grey value of the pixel with the grey values of the the two neighbours on each side and determines if the pixel should be corrected.

The hotpixel correction is enabled with the property `Correction_EnHotpixel`.

Only pixels brighter than a predefined grey value (`Correction_HotpixelMinVal`) are corrected. The value `Correction_HotpixelMinVal` can be modified by the user.

5.6 Crosshairs

5.6.1 Functionality

The crosshairs inserts a vertical and horizontal line into the image. The width of these lines is one pixel. The grey level is defined by a 12 bit value (0 means black, 4095 means white). This allows to set any grey level to get the maximum contrast depending on the acquired image. The x/y position and the grey level can be set via the camera software. Figure Fig. 5.19 shows two examples of the activated crosshairs with different grey values. One with white lines and the other with black lines.

The 12-bit format of the grey level was chosen to be compatible with other Photonfocus cameras.

The x- and y-positon is absolute to the sensor pixel matrix. It is independent on the ROI configuration.

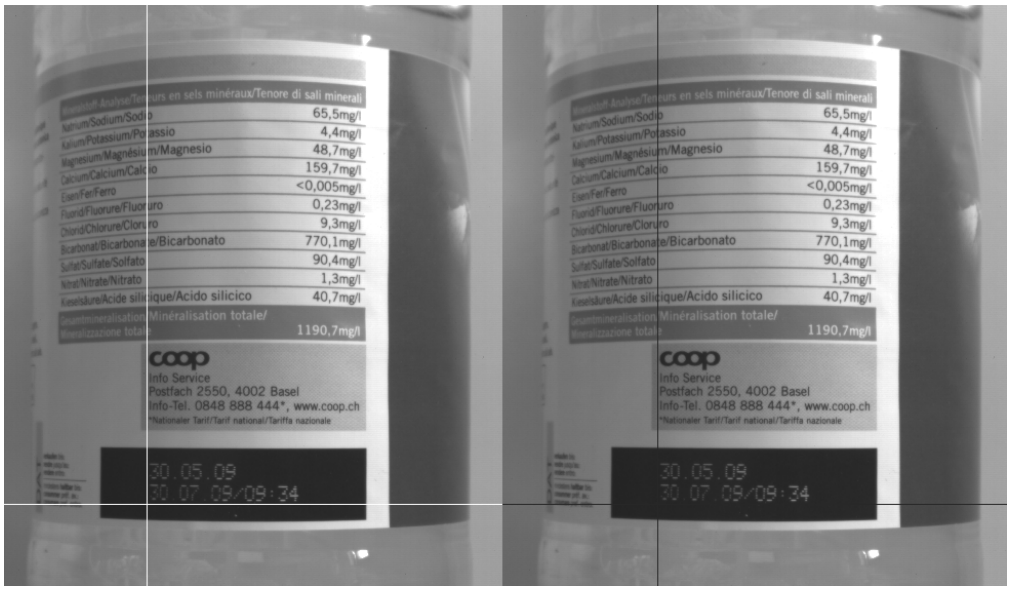

Figure 5.19: Crosshairs Example with different grey values

5.7 Image Information

There are camera properties available that give information about the acquired images, such as an image counter, average image value and the number of missed trigger signals. These properties can be queried by software. Alternatively, a status line within the image data can be switched on that contains all the available image information.

5.7.1 Counters and Average Value

Image counter The image counter provides a sequential number of every image that is output. After camera startup, the counter counts up from 0 (counter width 24 bit). The counter can be reset by the camera control software.

Real Time counter The time counter starts at 0 after camera start, and counts real-time in units of 1 micro-second. The time counter can be reset by the software in the SDK (Counter width 32 bit).

Missed trigger counter The missed trigger counter counts trigger pulses that were ignored by the camera because they occurred within the exposure or read-out time of an image. In free-running mode it counts all incoming external triggers (counter width 8 bit / no wrap around) (see also Section 5.2.10).

Missed burst trigger counter When the camera is in burst trigger mode (see Section 5.2.7), a missed burst trigger counter will be incremented, when a subsequent external trigger (`TriggerMode=On`) is applied while a burst sequence is running (see also Section 5.2.10).

Average image value The average image value gives the average of an image in 16 bit format (0 .. 65535 DN), regardless of the currently used grey level resolution.

5.7.2 Status Line

If enabled, the status line replaces the last row of the image with camera status information. Every parameter is coded into fields of 4 pixels (LSB first) and uses the lower 8 bits of the pixel value, so that the total size of a parameter field is 32 bit (see Fig. 5.20). The assignment of the parameters to the fields is listed in Table 5.5.

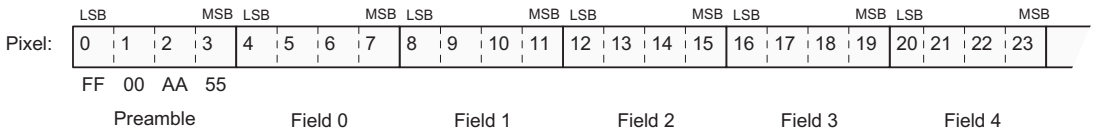
LSB MSB LSB MSB LSB MSB LSB MSB LSB MSB LSB MSB
Pixel:
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
FF 00 AA 55
Preamble
Field 0
Field 1
Field 2
Field 3
Field 4

Figure 5.20: Status line parameters replace the last row of the image

Start pixel index	Parameter width [bit]	Parameter Description
0	32	Preamble: 0x55AA00FF
4	24	Image Counter (see Section 5.7.1)
8	32	Real Time Counter (see Section 5.7.1)
12	8	Missed Trigger Counter (see Section 5.7.1)
16	16	Image Average Value("raw" data without taking in account gain settings) (see Section 5.7.1)
20	24	Integration Time in units of clock cycles (see Table 4.3)
24	16	Reserved (Burst Trigger Number)
28	8	Missed Burst Trigger Counter
32	11	Horizontal start position of ROI (OffsetX)
36	11	Horizontal end position of ROI (= OffsetX + Width - 1)
40	11	Vertical start position of ROI (OffsetY). In MROI-mode this parameter is the start position of the first ROI.
44	11	Number of rows - 1 (HeightInterface - 1)
48	2	Trigger Source. 0: TriggerMode=Off; 1: TriggerMode=On, TriggerSource=PLC_Q4; 2: TriggerMode=On, TriggerSource=Line1; 3: TriggerMode=On, TriggerSource=Software; 4: TriggerMode=On, TriggerSource=ABTrigger.
52	2	Digital Gain
56	2	Digital Offset
60	16	Camera Type Code (see Table 5.6)
64	32	Camera Serial Number
68	32	Reserved
72	32	Custom value: value of register StatusLineCustomValue that can be set by the user
76	16	FineGain. This is fixed a point value in the format: 4 digits integer value, 12 digits fractional value.
80	24	Encoder Position (only available in some models, see Appendix B).
84	32	Reserved
88	32	Reserved
92	4	Trigger Level: signal level of the trigger input signal (only available in some models, see Appendix B). Bit 0: PLC_Q4: Bit 1: Line1; Bit 2: PLC_Q6 (A-Trigger); Bit 3: PLC_Q7 (B-Trigger).

Table 5.5: Assignment of status line fields

5.7.3 Camera Type Codes

Camera Model	Camera Type Code
MV1-R1280-50-G2-16	470

Table 5.6: Type codes of Photonfocus MV1-R1280 GigE camera series

5.8 Test Images

Test images are generated in the camera FPGA, independent of the image sensor. They can be used to check the transmission path from the camera to the acquisition software. Independent from the configured grey level resolution, every possible grey level appears the same number of times in a test image. Therefore, the histogram of the received image must be flat.

A test image is a useful tool to find data transmission errors or errors in the access of the image buffers by the acquisition software.

The analysis of the test images with a histogram tool gives gives a flat histogram only if the image width is a multiple of 1024 (in 10 bit or 12 bit mode) or 256 (in 8 bit mode). The height should be a multiple of 1024 In 12 bit mode.

5.8.1 Ramp

Depending on the configured grey level resolution, the ramp test image outputs a constant pattern with increasing grey level from the left to the right side (see Fig. 5.21).

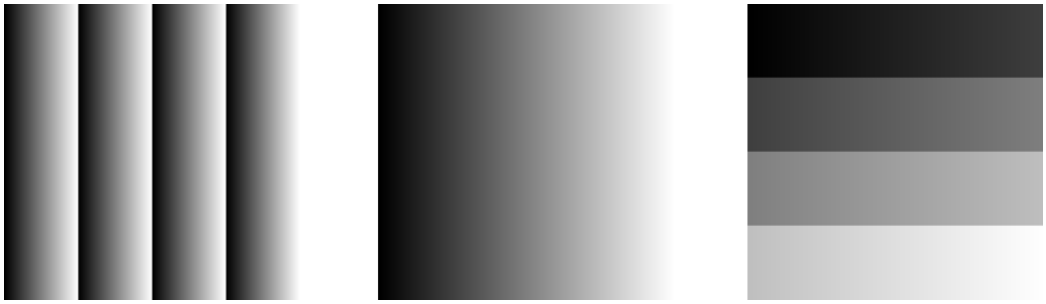

Figure 5.21: Ramp test images: 8 bit (left), 10 bit (middle), 12 bit (right)

5.8.2 LFSR

The LFSR (Linear Feedback Shift Register) test image outputs a constant pattern with a pseudo-random grey level sequence containing every possible grey level that is repeated for every row. The LFSR test pattern was chosen because it leads to a very high data toggling rate, which stresses the interface electronic and the cable connection.

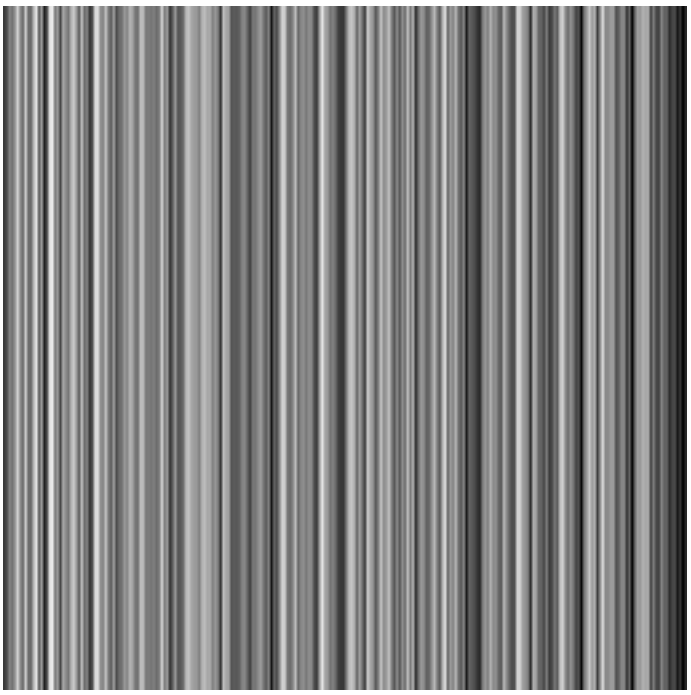

Figure 5.22: LFSR (linear feedback shift register) test image

In the histogram you can see that the number of pixels of all grey values are the same.

Please refer to application note [AN026] for the calculation and the values of the LFSR test image.

5.8.3 Troubleshooting using the LFSR

To control the quality of your complete imaging system enable the LFSR mode, set the camera window to 1024 x 1024 pixels (x=0 and y=0) and check the histogram. If your image acquisition application does not provide a real-time histogram, store the image and use a graphic software tool (e.g. ImageJ) to display the histogram.

In the LFSR (linear feedback shift register) mode the camera generates a constant pseudo-random test pattern containing all grey levels. If the data transmission is correctly received, the histogram of the image will be flat (Fig. 5.23). On the other hand, a non-flat histogram (Fig. 5.24) indicates problems, that may be caused either by a defective camera, by problems in the acquisition software or in the transmission path.
In robots applications, the stress that is applied to the camera cable is especially high due to the fast movement of the robot arm. For such applications, special drag chain capable cables are available. Please contact the Photonfocus Support for consulting expertise.

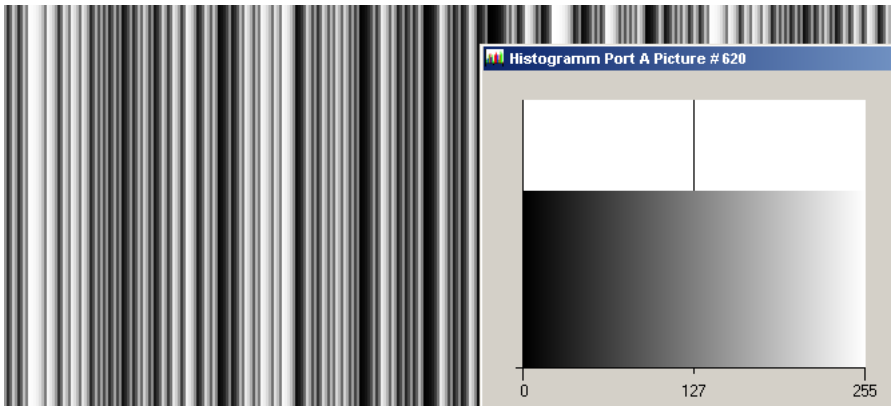

Figure 5.23: LFSR test pattern received and typical histogram for error-free data transmission

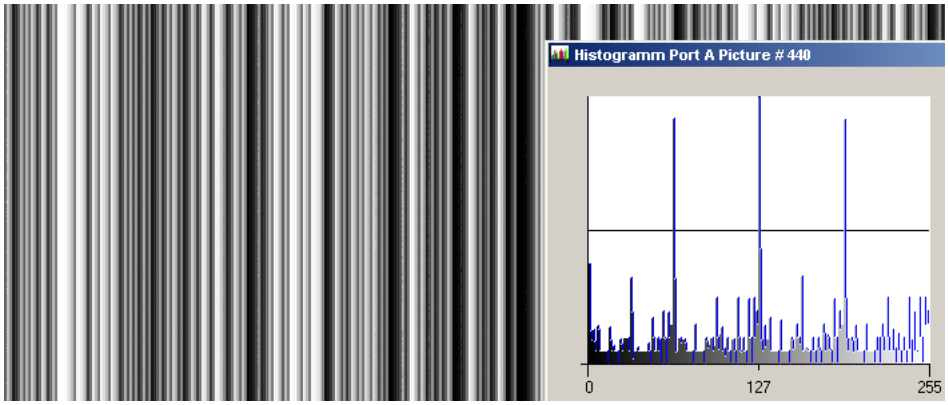

Figure 5.24: LFSR test pattern received and histogram containing transmission errors

6

Hardware Interface

6.1 GigE Connector

The GigE cameras are interfaced to external components via

- an Ethernet jack (RJ45) to transmit configuration, image data and trigger.
- a 12 pin subminiature connector for the power supply, Hirose HR10A-10P-12S (female) .

The connectors are located on the back of the camera. Fig. 6.1 shows the plugs and the status LED which indicates camera operation.

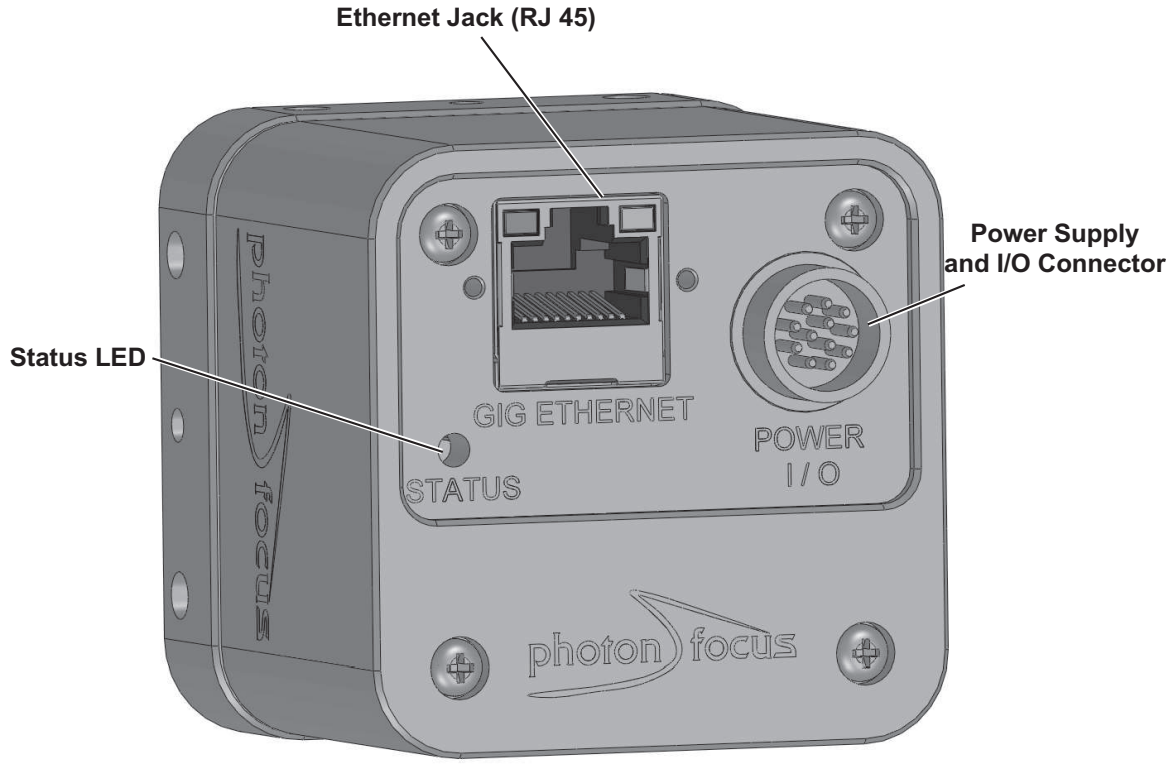

Figure 6.1: Rear view of the GigE camera

6.2 Power Supply Connector

The camera requires a single voltage input (see Table 4.4). The camera meets all performance specifications using standard switching power supplies, although well-regulated linear power supplies provide optimum performance.

It is extremely important that you apply the appropriate voltages to your camera. Incorrect voltages will damage the camera.

A suitable power supply can be ordered from your Photonfocus dealership.

For further details including the pinout please refer to Appendix A.

6.3 Status Indicator (GigE cameras)

A dual-color LED on the back of the camera gives information about the current status of the GigE CMOS cameras.

LED Green	It blinks slowly when the camera is not grabbing images.When the camera is grabbing images the LED blinks at a rate equal to the frame rate. At slow frame rates, the LED blinks. At high frame rates the LED changes to an apparently continuous green light, with intensity proportional to the ratio of readout time over frame time.
LED Red	Red indicates an active serial communication with the camera.

Table 6.1: Meaning of the LED of the GigE CMOS cameras

6.4 Power and Ground Connection for GigE G2 Cameras

The interface electronics is isolated from the camera electronics and the power supply including the line filters and camera case. Fig. 6.2 shows a schematic of the power and ground connections in the G2 camera models.

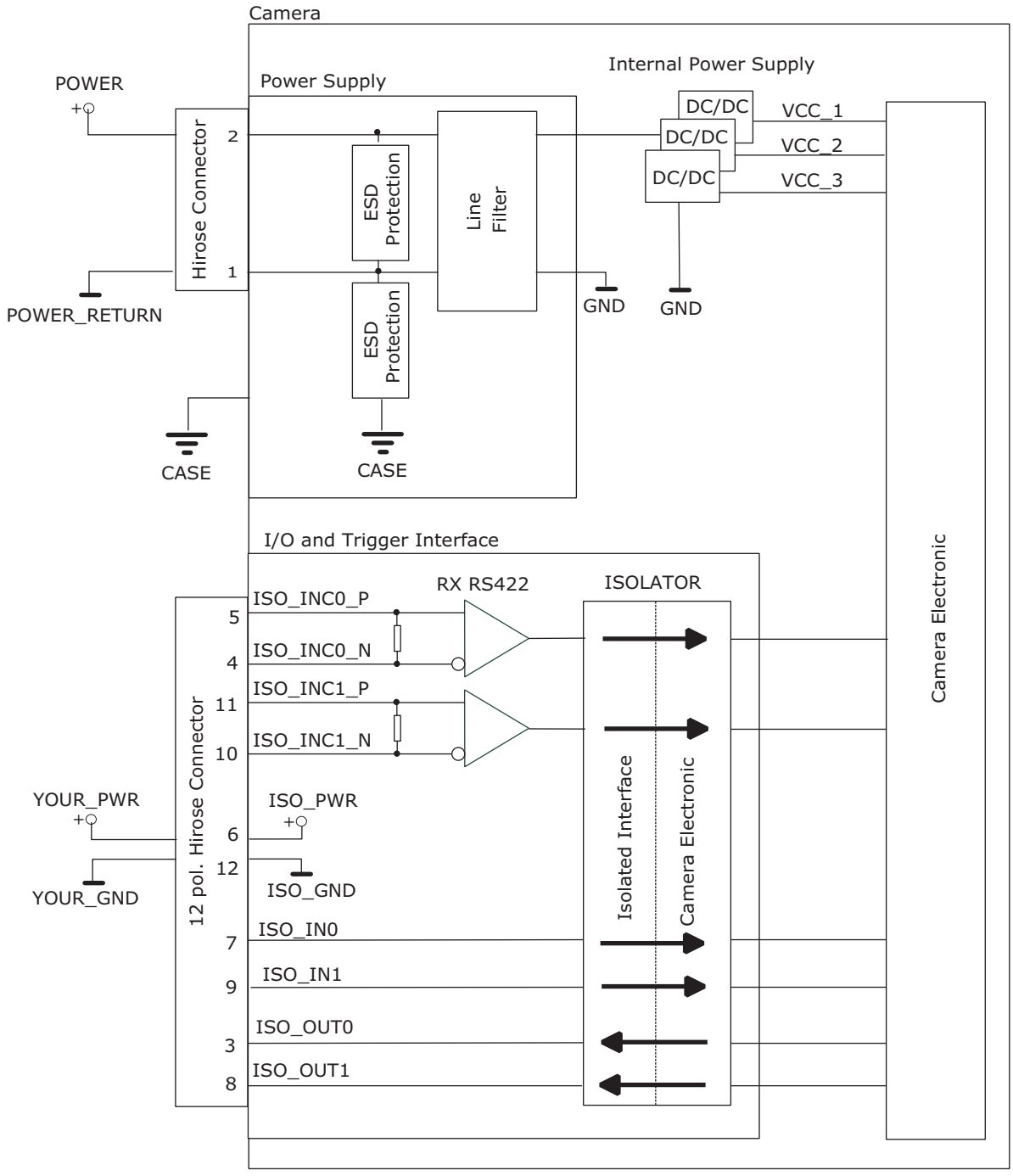

Figure 6.2: Schematic of power and ground connections in G2 camera models

6.5 Trigger and Strobe Signals for GigE Cameras

6.5.1 Overview

The 12-pol. Hirose power connector contains two external trigger inputs, two strobe outputs and two differential inputs (G2 models: RS-422, H2 models: HTL). All inputs and outputs are connected to the Programmable Logic Controller (PLC) (see also Section 6.6) that offers powerful operations.

The pinout of the power connector is described in Section A.1.

G2 models: ISO_INC0 and ISO_INC1 RS-422 inputs have -10 V to +13 V extended common mode range.

H2 models: The voltage level for the HTL interface should be given by the user by means of connecting the encoder power pin (HTL_ENC_PWR) and the ISO_PWR pin to the same power supply within a range between 10 and 30V. In the same way, encoder ground (HTL_ENC_GND) and ISO_GND signals should be connected to the same ground in order to guarantee the good reception of the differential signals.

ISO_OUT0 and ISO_OUT1 have different output circuits (see also Section 6.5.2).

A suitable trigger breakout cable for the Hirose 12 pol. connector can be ordered from your Photonfocus dealership.

Simulation with LTSpice is possible, a simulation model can be downloaded from our web site www.photonfocus.com on the software download page (in Support section). It is filed under "Third Party Tools".

Don’t connect single-ended signals to the differential inputs ISO_INC0 and ISO_INC1.

Fig. 6.3 shows the schematic of the inputs and outputs for the G2 models and Fig. 6.4 for the H2 models. All inputs and outputs are isolated. ISO_VCC is an isolated, internally generated voltage.

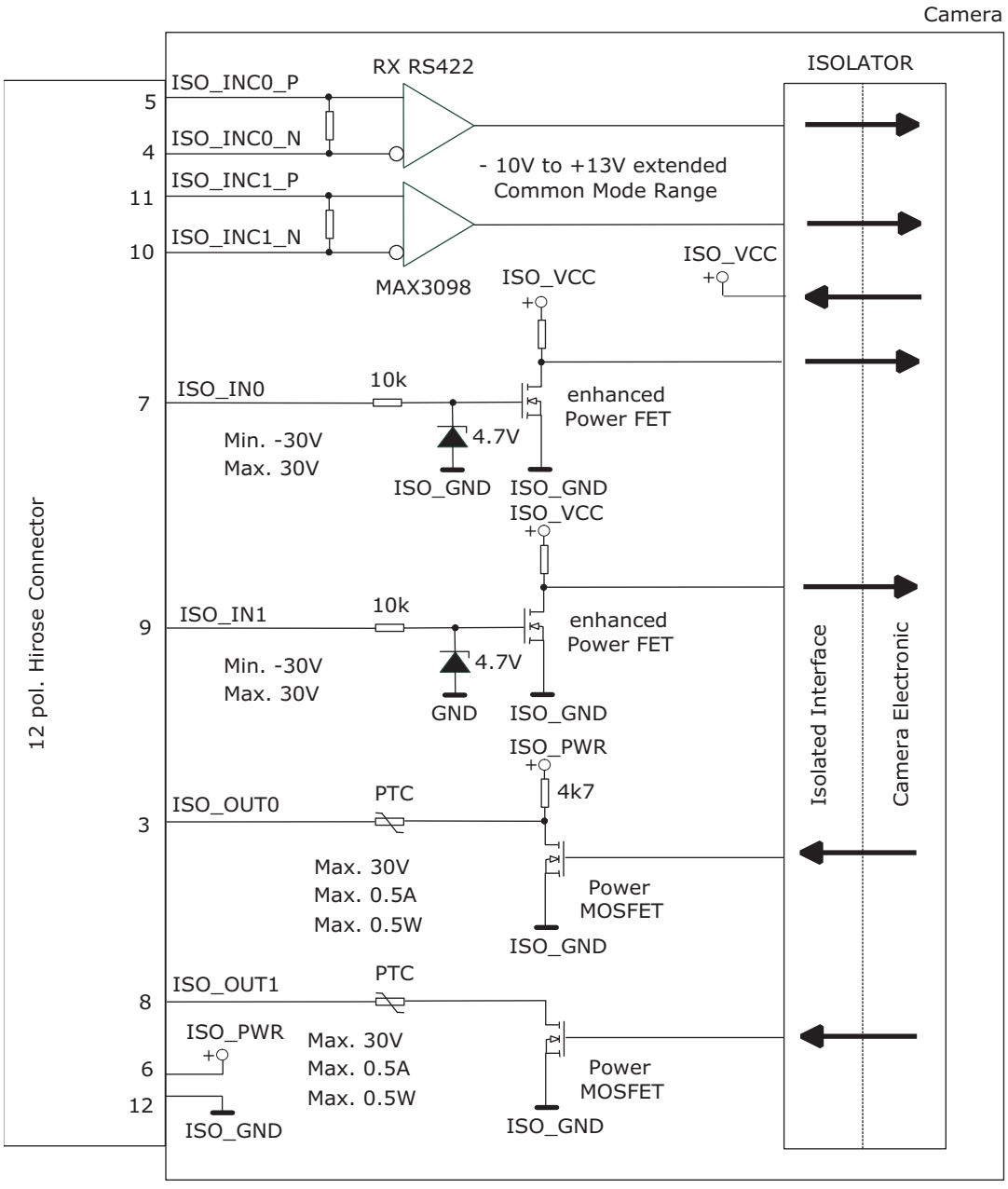

Figure 6.3: Schematic of inputs and output (G2 models)

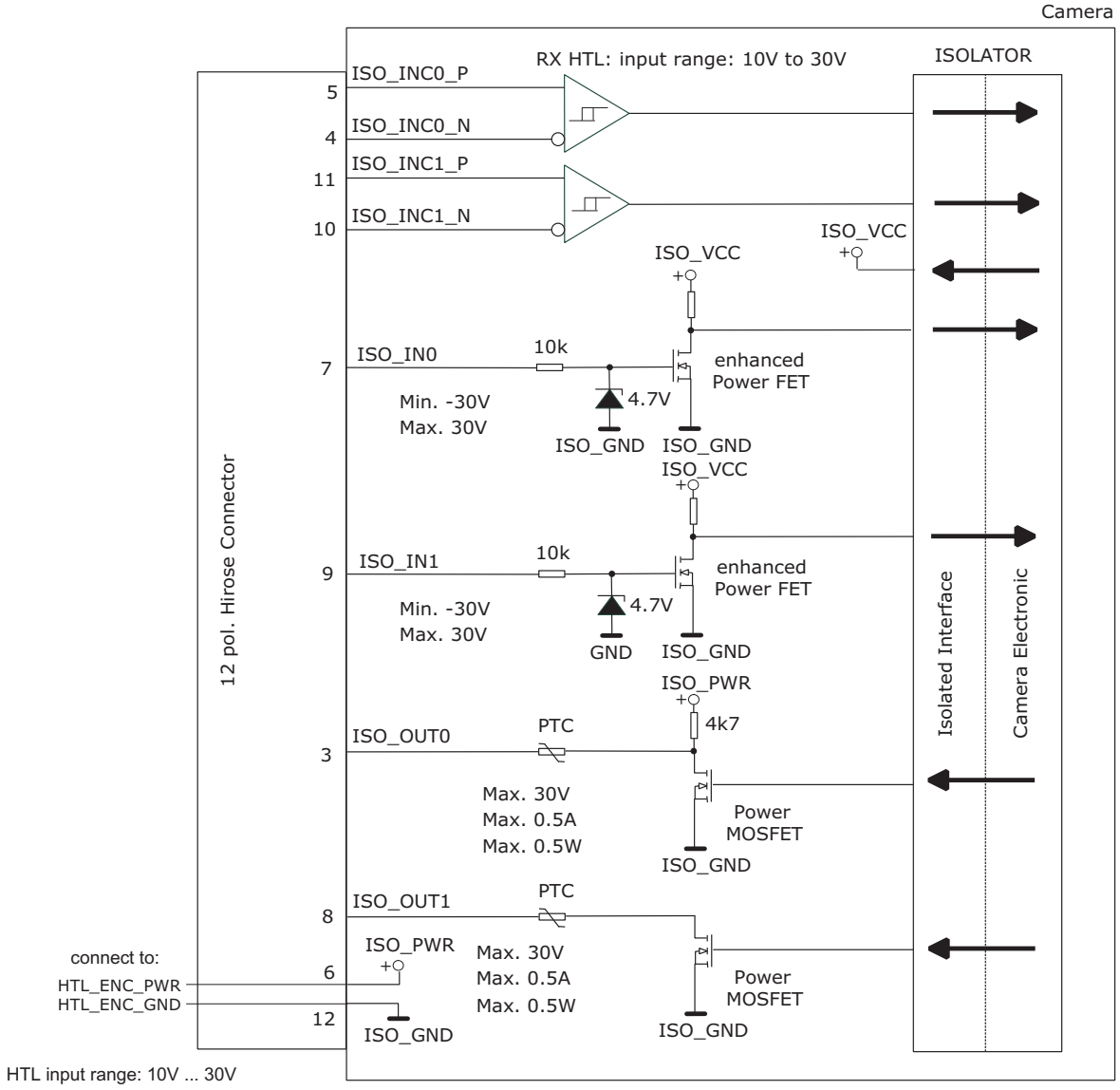

Figure 6.4: Schematic of inputs and output (H2 models)

6.5.2 Single-ended Inputs

ISO_IN0 and ISO_IN1 are single-ended isolated inputs. The input circuit of both inputs is identical (see Fig. 6.3).

Fig. 6.5 shows a direct connection to the ISO_IN inputs.

In the camera default settings the PLC is configured to connect the ISO_IN0 to the PLC_Q4 camera trigger input. This setting is listed in Section 7.7.2.

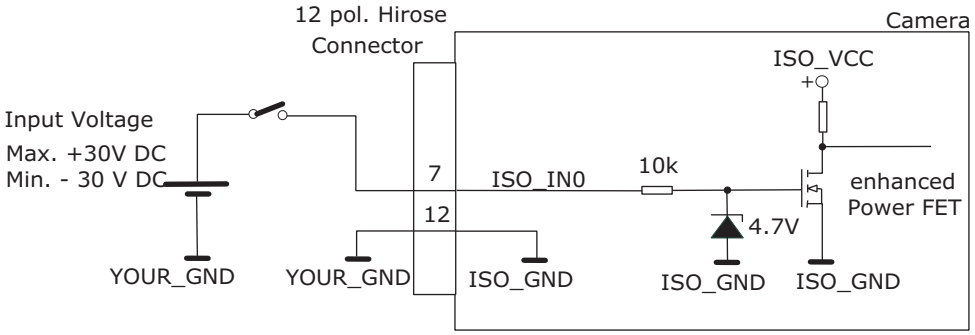

Figure 6.5: Direct connection to ISO_IN

Fig. 6.6 shows how to connect ISO_IN to TTL logic output device.

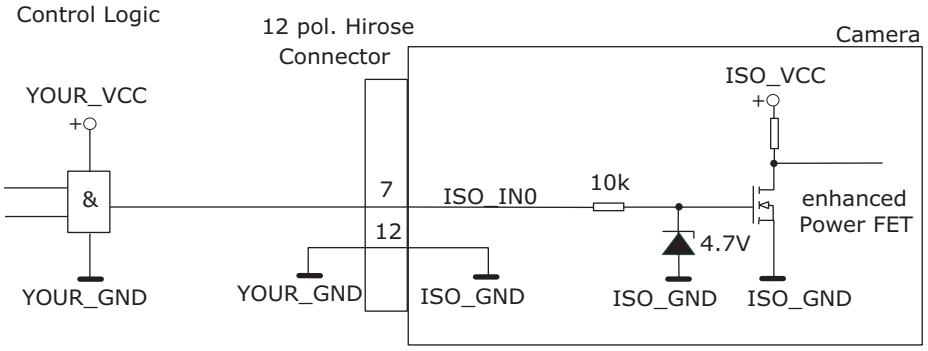

Figure 6.6: Connection to ISO_IN from a TTL logic device

6.5.3 Single-ended Outputs

ISO_OUT0 and ISO_OUT1 are single-ended isolated outputs.

ISO_OUT0 and ISO_OUT1 have different output circuits: ISO_OUT1 doesn't have a pullup resistor and can be used as additional Strobe out (by adding Pull up) or as controllable switch. Maximal ratings that must not be exceeded: voltage: 30 V, current: 0.5 A, power: 0.5 W.

Fig. 6.7 shows the connection from the ISO_OUT0 output to a TTL logic device. PTC is a current limiting device.

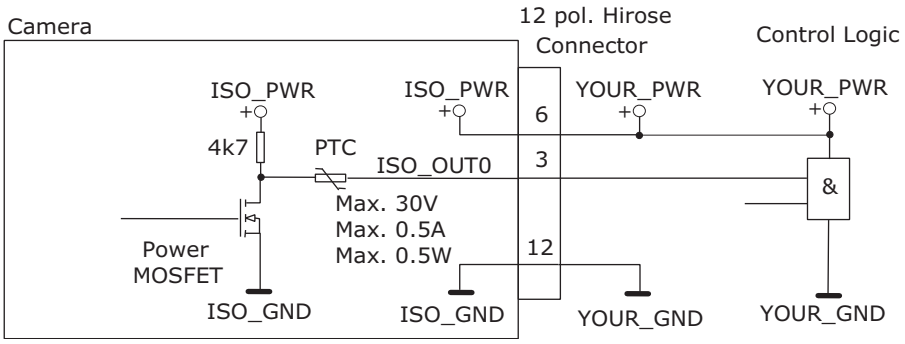

Figure 6.7: Connection example to ISO_OUT0

Fig. 6.8 shows the connection from ISO_OUT1 to a TTL logic device. PTC is a current limiting device.

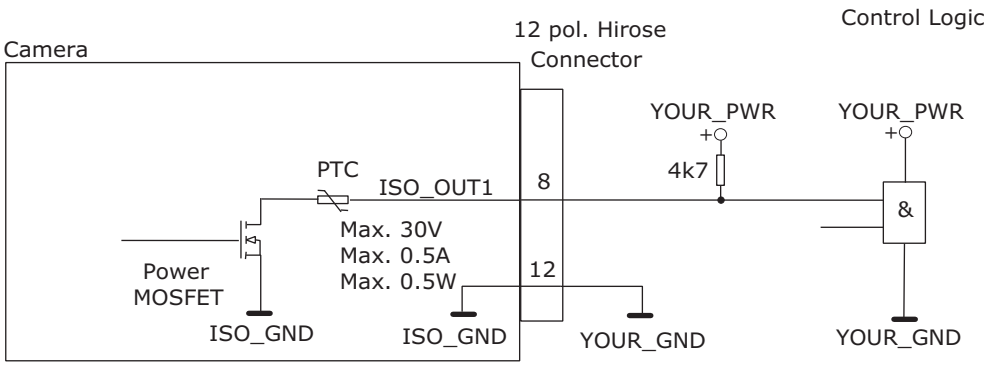

Figure 6.8: Connection from the ISO_OUT1 output to a TTL logic device

Fig. 6.9 shows the connection from ISO_OUT1 to a LED.

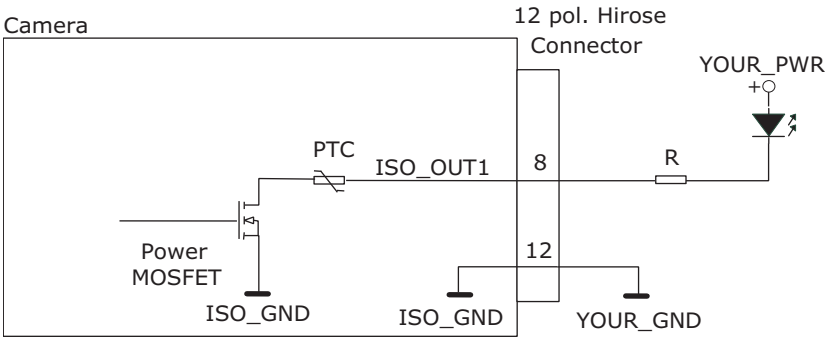

Figure 6.9: Connection from ISO_OUT1 to a LED

Respect the limits of the POWER MOSFET in the connection to ISEO_OUT1. Maximal ratings that must not be exceeded: voltage: 30 V, current: 0.5 A, power: 0.5 W. (see also Fig. 6.10). The type of the Power MOSFET is: International Rectifier IRLML0100TRPbF.

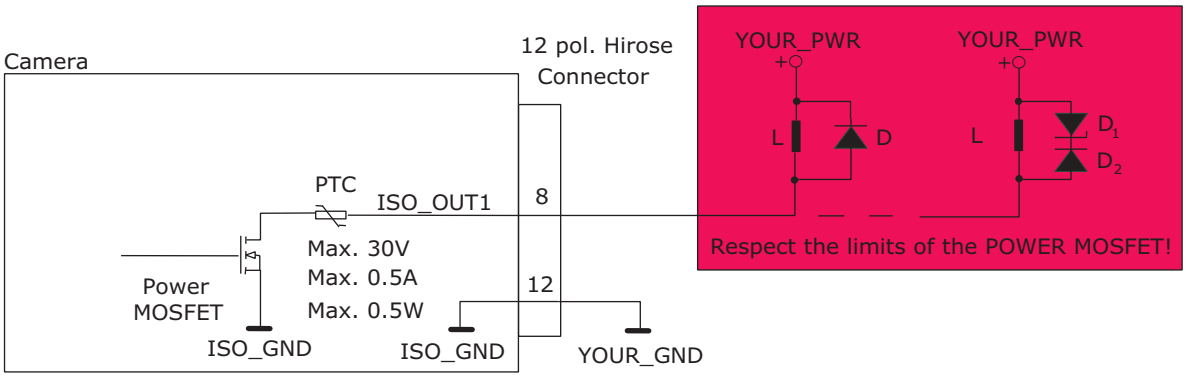

Figure 6.10: Limits of ISO_OUT1 output

6.5.4 Differential RS-422 Inputs (G2 models)

ISO_INC0 and ISO_INC1 are isolated differential RS-422 inputs (see also Fig. 6.3). They are connected to a Maxim MAX3098 RS-422 receiver device. Please consult the data sheet of the MAX3098 for connection details.

Don't connect single-ended signals to the differential inputs ISO_INC0 and ISO_INC1 (see also Fig. 6.11).

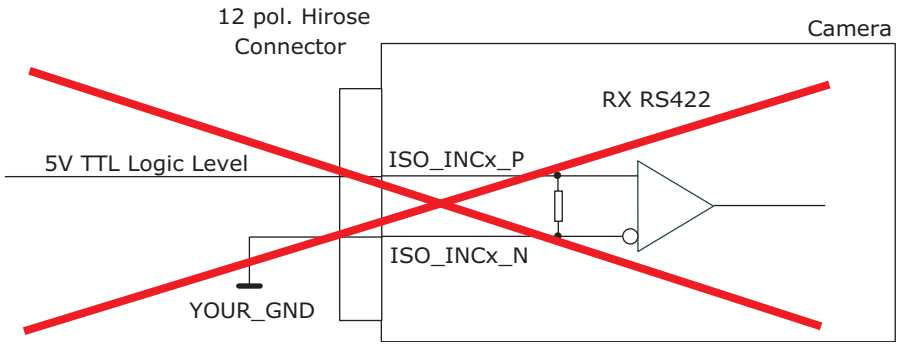

Figure 6.11: Incorrect connection to ISO_INC inputs

6.5.5 Master / Slave Camera Connection

The trigger input of one Photonfocus G2 camera can easily connected to the strobe output of another Photonfocus G2 camera as shown in Fig. 6.12. This results in a master/slave mode where the slave camera operates synchronously to the master camera.

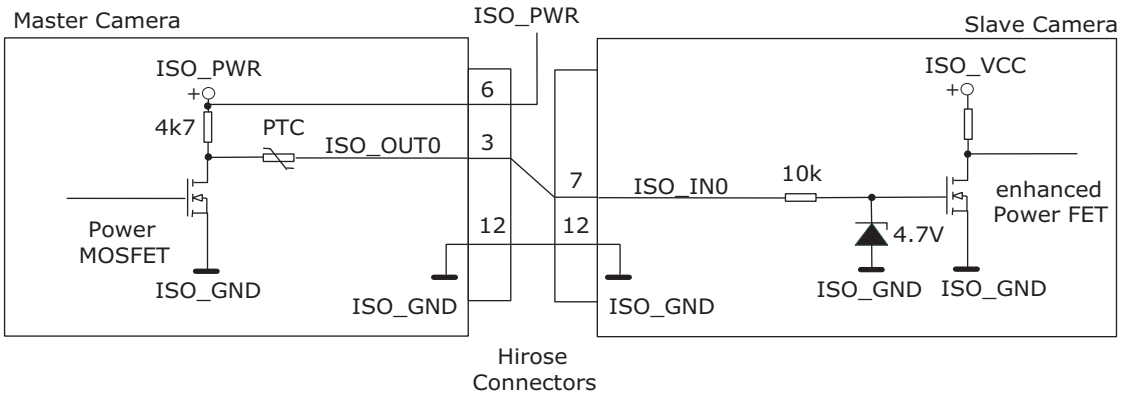

Figure 6.12: Master / slave connection of two Photonfocus G2 cameras

6.5.6 I/O Wiring

The Photonfocus cameras include electrically isolated inputs and outputs. Take great care when wiring trigger and strobe signals to the camera, specially over big distances (a few meters) and in noisy environments. Improper wiring can introduce ground loops which lead to malfunction of triggers and strobes.

There are two roads to avoid ground loops:

- Separating I/O ground and power supply (ISO_GND and ISO_PWR) from camera power (CAM_GND, CAM_PWR)
- Using a common power supply for camera and I/O signals with star-wiring

Separate Grounds

To separate the signal and ground connections of the camera (CAM_GND, CAM_PWR, data connections) from the I/O connections (ISO_GND, ISO_PWR, ISO_IN, ISO_OUT) is one way to avoid ground loops. Fig. 6.13 shows a schematic of this setup. In this setup the power supplies for the camera and for ISO power must be separate devices.

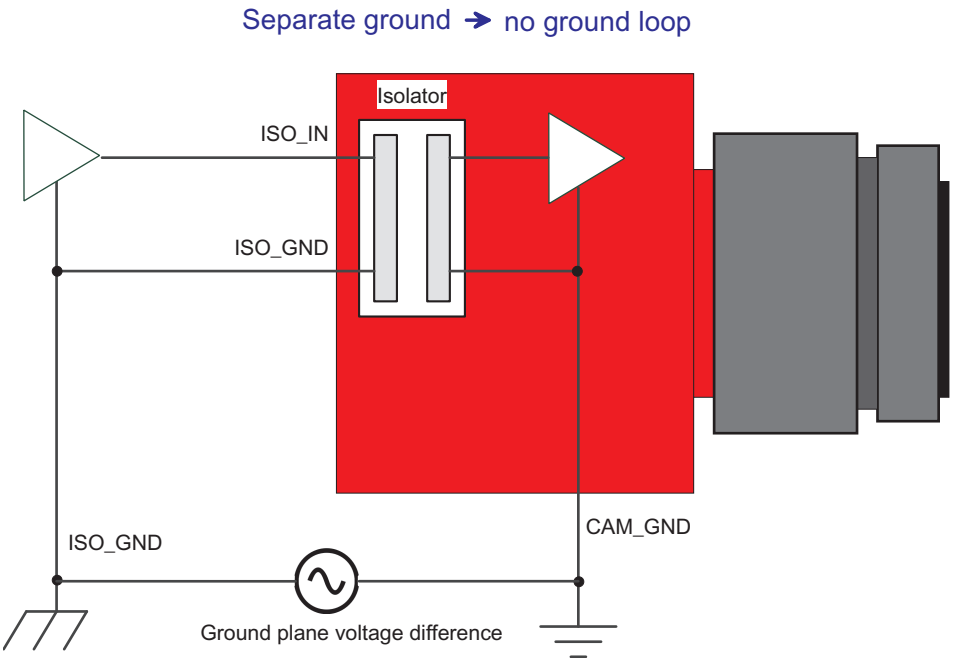

Figure 6.13: I/O wiring using separate ground

Common Grounds with Star Wiring

Ground loops can be avoided using "star wiring", i.e. the wiring of power and ground connections originate from one "star point" which is typically a power supply. Fig. 6.14 shows a schematic of the star-wiring concept.

Fig. 6.15 shows a schematic of the star-wiring concept applied to a Photonfocus GigE camera.The power supply and ground connections for the camera and for the I/O are connected to the same power supply which acts as the "Star Point".

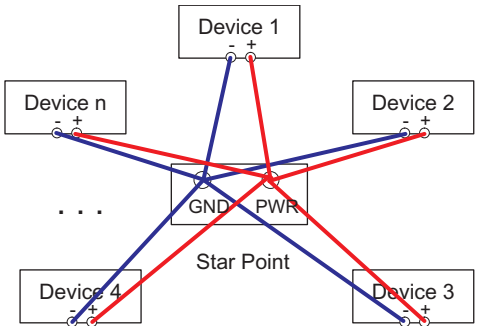

Figure 6.14: Star-wiring principle

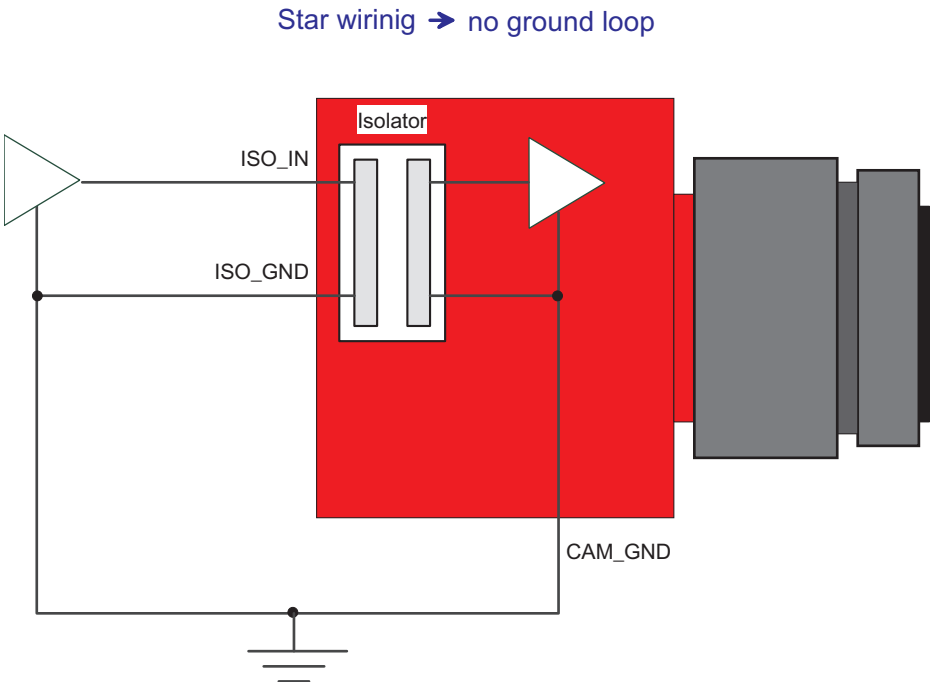

Figure 6.15: I/O wiring using star-wiring

Fig. 6.16 shows an example of how to connect a flash light and a trigger source to the camera using star-wiring. The trigger in this example is generated from a light barrier. Note how the power and ground cables are connected to the same power supply.

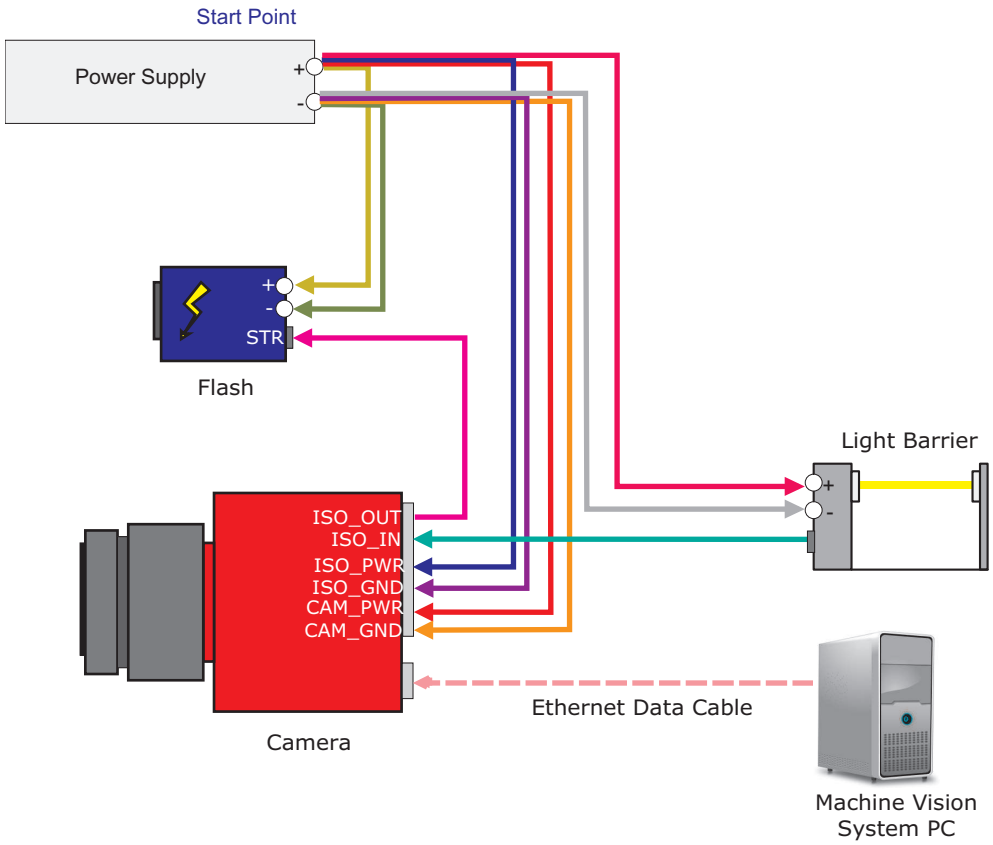

Figure 6.16: I/O wiring using star-wiring example

An example of improper wiring that causes a ground loop is shown in Fig. 6.17.

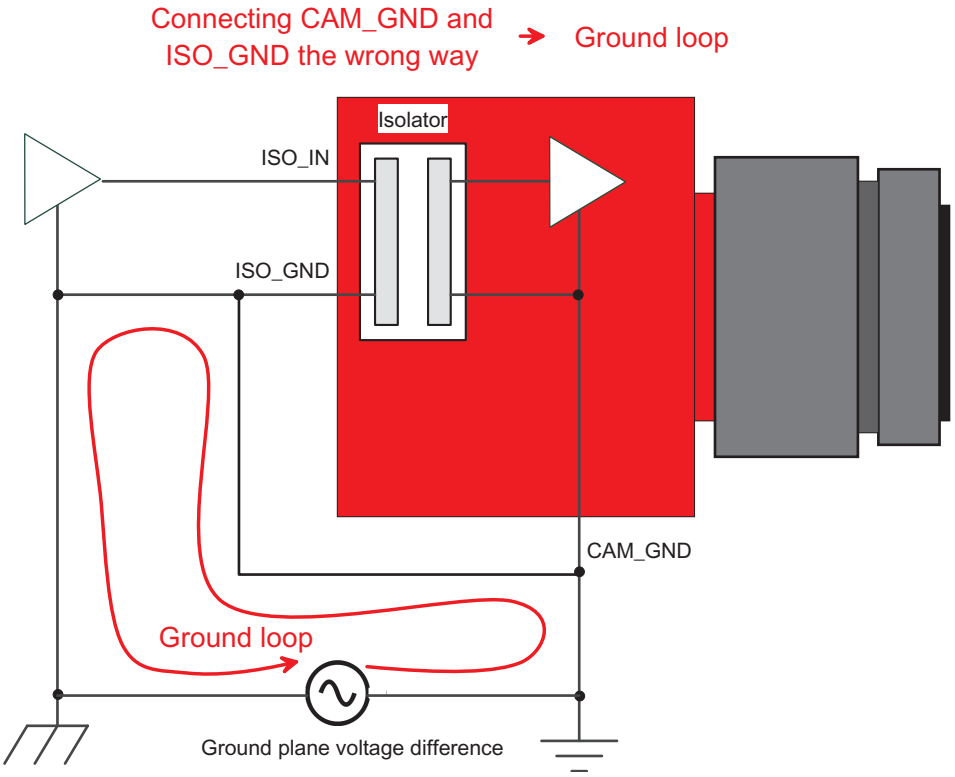

Figure 6.17: Improper I/O wiring causing a ground loop

6.6 PLC connections

The PLC (Programmable Logic Controller) is a powerful device where some camera inputs and outputs can be manipulated and software interrupts can be generated. Sample settings and an introduction to PLC are shown in Section 7.7. PLC is described in detail in the document [PLC].

Name	Direction	Description
A0 (Line0)	Power connector -> PLC	ISO_IN0 input signal
A1(Line1)	Power connector -> PLC	ISO_IN1 input signal
A2 (Line2)	Power connector -> PLC	ISO_INC0 input signal
A3 (Line3)	Power connector -> PLC	ISO_INC1 input signal
A4	camera head -> PLC	FVAL (Frame Valid) signal
A5	camera head -> PLC	LVAL (Line Valid) signal
A6	camera head -> PLC	DVAL (Data Valid) signal
A7	camera head -> PLC	Reserved (CL_SPARE)
Q0	PLC ->	not connected
Q1	PLC -> power connector	ISO_OUT1 output signal (signal is inverted)
Q2	PLC ->	not connected
Q3	PLC ->	not connected
Q4	PLC -> camera head	PLC_Q4 camera trigger
Q5	PLC -> camera head	PLC_Q5 (only available on cameras with Counter Reset External feature)
Q6	PLC -> camera head	Incremental encoder A signal (only available on cameras with AB Trigger feature)
Q7	PLC -> camera head	Incremental encoder B signal (only available on cameras with AB Trigger feature)

Table 6.2: Connections to/from PLC

7

Software

7.1 Software for Photonfocus GigE Cameras

The following packages for Photonfocus GigE (G2 / H2) cameras are available on the Photonfocus website (www.photonfocus.com):

eBUS SDK Contains the Pleora SDK and the Pleora GigE filter drivers. Many examples of the SDK are included.

PFInstaller Contains the PF_GEVPlayer, the DR1 decoding DLL, a property list for every GigE camera and additional documentation and examples. The option `GigE_Tools, PF_GEVPlayer, SDK examples and doc for GigE cameras` must be selected.

7.2 PF_GEVPlayer

The camera parameters can be configured by a Graphical User Interface (GUI) tool for Gigabit Ethernet Vision cameras or they can be programmed with custom software using the SDK.

A GUI tool that can be downloaded from Photonfocus is the PF_GEVPlayer. How to obtain and install the software and how to connect the camera is described in Chapter 3.

After connecting to the camera, the camera properties can be accessed by clicking on the `GEV Device control` button (see also Section 7.2.2).

The PF_GEVPlayer is described in more detail in the GEVPlayer Quick Start Guide [GEVQS] which is included in the PFInstaller.

There is also a GEVPlayer in the Pleora eBUS package. It is recommended to use the PF_GEVPlayer as it contains some enhancements for Photonfocus GigE cameras such as decoding the image stream in DR1 cameras.

7.2.1 PF_GEVPlayer main window

After connecting the camera (see Chapter 3), the main window displays the following controls (see Fig. 7.1):

Disconnect Disconnect the camera

Mode Acquisition mode

Play Start acquisition

Stop Stop acquisition

Acquisition Control Mode Continuous, Single Frame or Multi Frame modes. The number of frames that are acquired in Multi Frame mode can be set in the GEV Device Control with `AcquisitionFrameCount` in the `AcquisitionControl` category.

Communication control Set communication properties.

GEV Device control Set properties of the camera head, IP properties and properties of the PLC (Programmable Logic Controller, see also Section 6.6 and document [PLC]).

Image stream control Set image stream properties and display image stream statistics.

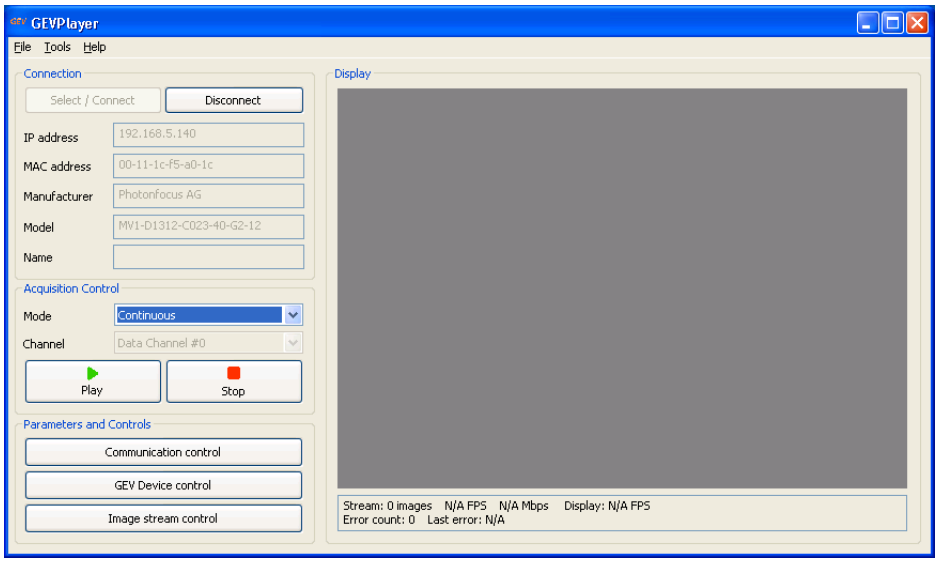

Figure 7.1: PF_GEVPlayer main window

Below the image display there are two lines with status information

7.2.2 GEV Control Windows

This section describes the basic use of the GEV Control windows, e.g. the `GEV Device Control` window.

The view of the properties in the control window can be changed as described below. At start the properties are grouped in categories which are expanded and whose title is displayed in bold letters. An overview of the available view controls of the GEV Control windows is shown in Fig. 7.2.

To have a quick overview of the available categories, all categories should be collapsed. The categories of interest can then be expanded again. If the name of the property is known, then the alphabetical view is convenient. If this is the first time that you use a Photonfocus GigE camera, then the visibility should be left to `Beginner`.

The description of the currently selected property is shown at the bottom ot the window.

After selecting a property from a drop-down box it is necessary to press <Enter> or to click with the mouse on the control window to apply the property value to the camera.

A red cross at the upper right corner of the GEV Control Window indicates a parameter error, i.e. a parameter is not correctly set. In this case you should check all properties. A red exclamation mark (!) at the right side of a parameter value indicates that this parameters has to be set correctly.

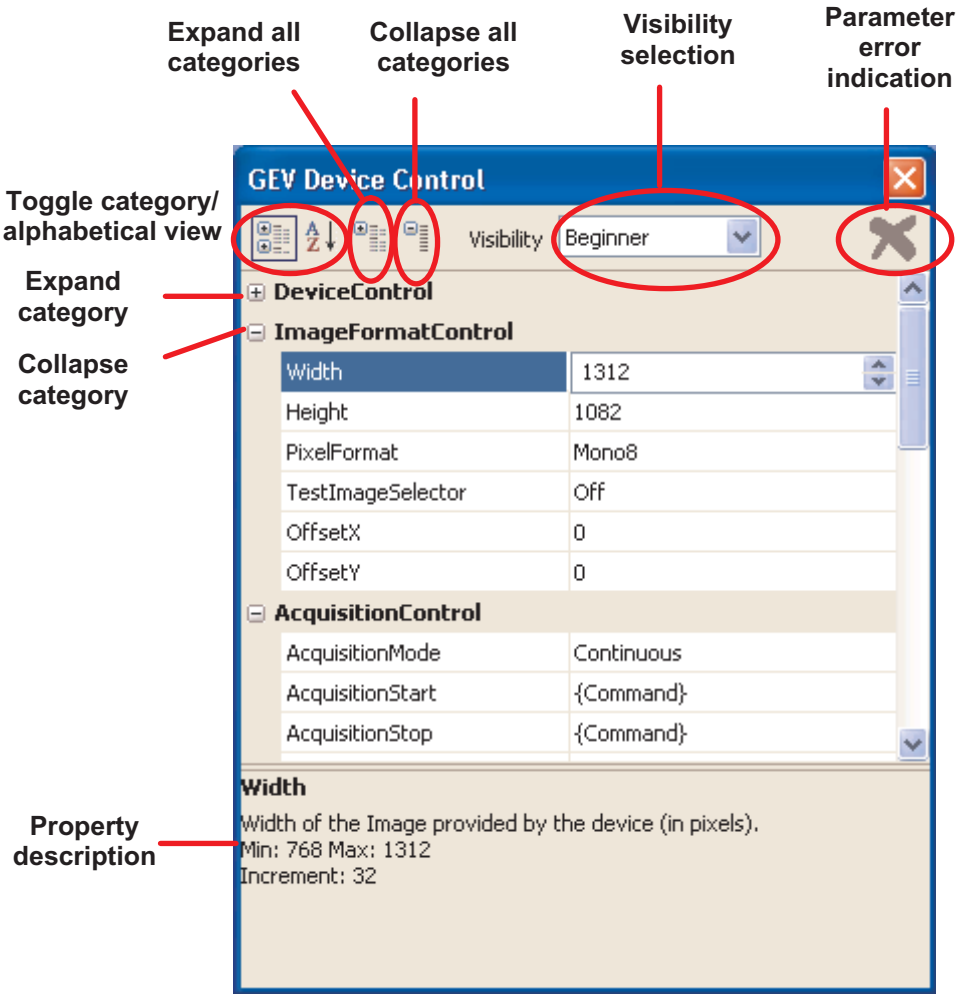

Figure 7.2: PF_GEVPlayer Control Window

7.2.3 Display Area

The images are displayed in the main window in the display area. A zoom menu is available when right clicking in the display area. Another way to zoom is to press the Ctrl button while using the mouse wheel.

7.2.4 White Balance (Colour cameras only)

A white balance utility is available in the PF_GEVPlayer in `Tools -> Image Filtering` (see Fig. 7.3). The gain of the colour channels can be adjusted manually by sliders or an auto white balance of the current image can be set by clicking on the `White Balance` button. To have a correct white balance setting, the camera should be pointed to a neutral reference (object that reflects all colours equally), e.g. a special grey reference card while clicking on the White Balance button.

The white balance settings that were made as described in this section, are applied by the PF_GEVPlayer software and are not stored in the camera. To store the colour gain values in the camera, the Gain settings in the GEV Device Control (in AnalogControl) must be used. If the gain properties in the camera are used, then the PF_GEVPlayer RGB Filtering should be disabled.

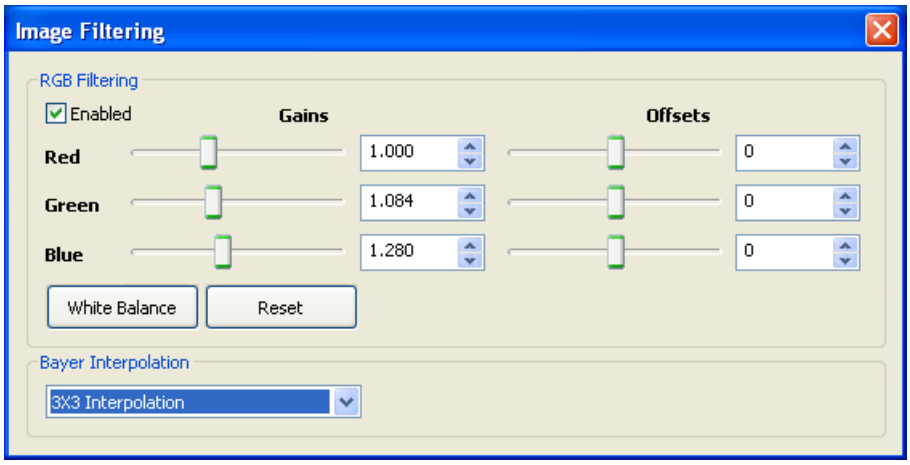

Figure 7.3: PF_GEVPlayer image filtering dialog

7.2.5 Save camera setting to a file

The current camera settings can be saved to a file with the PF_GEVPlayer (`File -> Save` or `Save As...`). This file can later be applied to camera to restore the saved settings (`File -> Open`), Note, that the Device Control window must not be open to do this.

The MROI and LUT settings are not saved in the file.

7.2.6 Get feature list of camera

A list of all features of the Photonfocus GigE cameras in HTML format can be found in the `GenICam_Feature_Lists` sub-directory (in `Start -> All Programs -> Photonfocus -> GigE_Tools`).

Alternatively, the feature list of the connected camera can be retrieved with the PF_GEVPlayer (`Tools -> Save Camera Features as HTML...`).

7.3 Pleora SDK

The eBUS package provides the PureGEV C++ SDK for image acquisition and the setting of properties. A help file is installed in the Pleora installation directory, e.g. `C:\Program Files\Pleora Technologies Inc\eBUS SDK\Documentation`.

Various code samples are installed in the installation directory, e.g. `C:\Program Files\Pleora Technologies Inc\eBUS SDK\Samples`. The sample `PvPipelineSample` is recommended to start with.

Samples that show how to set device properties are included in the PFInstaller that can be downloaded from the Photonfocus webpage.

7.4 Frequently used properties

A property list for every camera is included in the PFInstaller that can be downloaded from the Photonfocus webpage.

The following list shows some frequently used properties that are available in the Beginner mode. The category name is given in parenthesis.

Width (ImageFormatControl) Width of the camera image ROI (region of interest)

Height (ImageFormatControl) Width of the camera image ROI

OffsetX, OffsetY (ImageFormatControl) Start of the camera image ROI

ExposureTime (AcquisitionControl) Exposure time in microseconds

TriggerMode (AcquisitionControl) External triggered mode

TriggerSource (AcquisitionControl) Trigger source if external triggered mode is selected

Header_Serial (Info / CameraInfo) (Visiblity: Guru) Serial number of the camera

UserSetSave (UserSetControl) Saves the current camera settings to non-volatile flash memory.

7.5 Permanent Parameter Storage / Factory Reset

The property `UserSetSave` (in category `UserSetControl`) stores the current camera settings in the non-volatile flash memory. At power-up these values are loaded.

The property `UserSetSave` (in category `UserSetControl`) overwrites the current camera settings with the settings that are stored in the flash memory.

The command `CameraHeadFactoryReset` (in category `PhotonfocusMain`) restores the settings of the camera head

The property `CameraHeadStoreDefaults` (in category `PhotonfocusMain`) stores only the settings of the camera head in the flash memory. It is recommended to use `UserSetSave` instead, as all properties are stored.

The calibration values of the FPN calibration are not stored with `UserSetSave` (or `CameraHeadStoreDefaults`). Use the command `Correction_SaveToFlash` for this (see `Correction_SaveToFlash`).

7.6 Persistent IP address

It is possible to set a persistent IP address:

1. Set `GevPersistentIPAddress` (in category `TransportLayerControl`) to the desired IP address.
2. Set `GevPersistentSubnetMask` (in category `TransportLayerControl`) to the sub net mask.
3. Set `GevCurrentIPConfigurationPersistent` (in category `TransportLayerControl`) to True.
4. Set `GevCurrentIPConfigurationDHCP` (in category `TransportLayerControl`) to False.
5. The selected persistent IP address will be applied after a reboot of the camera.

7.7 PLC

7.7.1 Introduction

The Programmable Logic Controller (PLC) is a powerful tool to generate triggers and software interrupts. A functional diagram of the PLC tool is shown in Fig. 7.4. The PLC tool is described in detail with many examples in the [PLC] manual which is included in the PFInstaller.

The AB Trigger feature is not available on all camera revisions, see Appendix B for a list of available features.

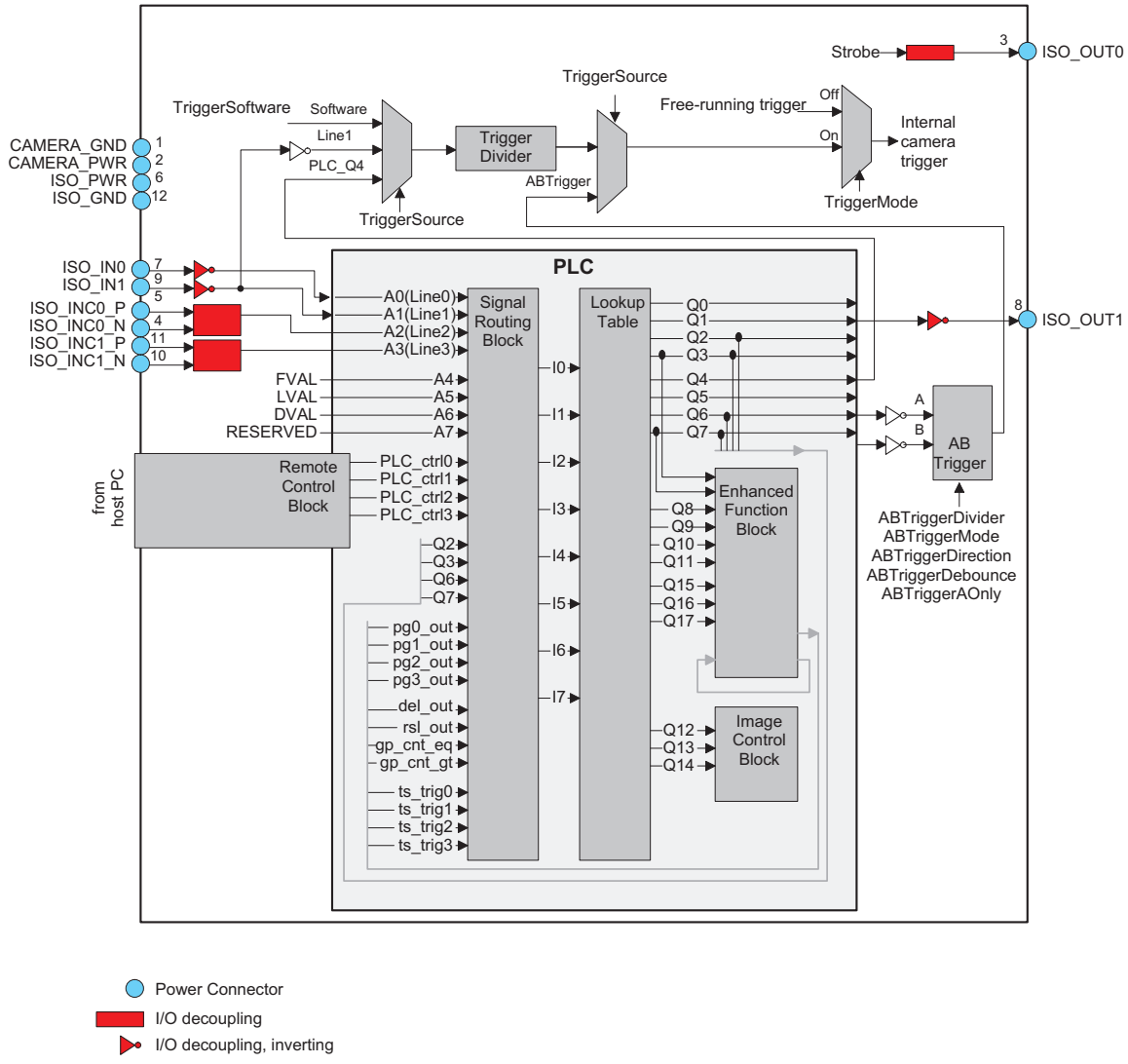

Figure 7.4: PLC functional overview and trigger connections

The simpliest application of the PLC is to connect a PLC input to a PLC output. The connection of the ISO_IN0 input to the PLC_Q4 camera trigger is given as an example. The resulting configuration is shown in Section 7.7.2.

1. Identify the PLC notation of the desired input. A table of the PLC mapping is given in Section 6.6. In our example, ISO_IN0 maps to A0 or Line0.
2. Select a Signal Routing Block (SRB) that has a connection to the desired PLC input and connect it to the PLC input. In our example, SRB PLC_I0 will be used as it has a connection to Line0. To connect the SRB to input, set PLC_I<x> to the input. In the example, set PLC_I0 to Line0.
3. Identify the PLC notation of the desired output. A table of the PLC mapping is given in Section 6.6. In the example Q4 is the desired output.
4. Connect the LUT that corresponds to the desired output to the SRB from step 2. In the example, PLC_Q4 is connected to PLC_I0. Note that every LUT has the capability to connect up to 4 inputs. In the example only the first input (PLC_Q4_Variable0) is used. The other inputs are ignored by setting the PLC_Q4_Variable to Zero and the PLC_Q4_Operator to Or for inputs 1 to 3.
5. If a PLC output is used to connect to a camera trigger, then the corresponding Trigger Source must be activated. In the example, TriggerSource is set to PLC_Q4 and TriggerMode is set to On.

7.7.2 PLC Settings for ISO_IN0 to PLC_Q4 Camera Trigger

This setting connects the ISO_IN0 to the internal camera trigger, see Table 7.1 (the visibility in the PF_GEVPlayer must be set to `Guru` for this purpose).

Feature	Value	Category
TriggerMode	On	AcquisitionControl
TriggerSource	PLC_Q4	AcquisitionControl
PLC_I0	Line0	<PLC>/SignalRoutingBlock
PLC_Q4_Variable0	PLC_I0_Not	<PLC>/LookupTable/Q4
PLC_Q4_Operator0	Or	<PLC>/LookupTable/Q4
PLC_Q4_Variable1	Zero	<PLC>/LookupTable/Q4
PLC_Q4_Operator1	Or	<PLC>/LookupTable/Q4
PLC_Q4_Variable2	Zero	<PLC>/LookupTable/Q4
PLC_Q4_Operator2	Or	<PLC>/LookupTable/Q4
PLC_Q4_Variable3	Zero	<PLC>/LookupTable/Q4

Table 7.1: PLC Settings for ISO_IN0 to PLC_Q4 Camera Trigger (<PLC> = in category IPEngine/ProgrammableLogicController)

7.7.3 PLC Settings for A/B Trigger from differential inputs

This settings connects the ISO_INC differential inputs to the A/B camera inputs. ISO_INC0 is mapped to the A signal and ISO_INC1 to the B signal, see Table 7.2 (the visibility in the PF_GEVPlayer must be set to `Guru` for this purpose).

The AB Trigger feature is not available on all camera revisions, see Appendix B for a list of available features.

Feature	Value	Category
TriggerMode	On	AcquisitionControl
TriggerSource	ABTrigger	AcquisitionControl
PLC_I2	Line2	<PLC>/SignalRoutingBlock
PLC_I3	Line3	<PLC>/SignalRoutingBlock
PLC_Q6_Variable0	PLC_I2	<PLC>/LookupTable/Q6
PLC_Q6_Operator0	Or	<PLC>/LookupTable/Q6
PLC_Q6_Variable1	Zero	<PLC>/LookupTable/Q6
PLC_Q6_Operator1	Or	<PLC>/LookupTable/Q6
PLC_Q6_Variable2	Zero	<PLC>/LookupTable/Q6
PLC_Q6_Operator2	Or	<PLC>/LookupTable/Q6
PLC_Q6_Variable3	Zero	<PLC>/LookupTable/Q6
PLC_Q7_Variable0	PLC_I3	<PLC>/LookupTable/Q7
PLC_Q7_Operator0	Or	<PLC>/LookupTable/Q7
PLC_Q7_Variable1	Zero	<PLC>/LookupTable/Q7
PLC_Q7_Operator1	Or	<PLC>/LookupTable/Q7
PLC_Q7_Variable2	Zero	<PLC>/LookupTable/Q7
PLC_Q7_Operator2	Or	<PLC>/LookupTable/Q7
PLC_Q7_Variable3	Zero	<PLC>/LookupTable/Q7

Table 7.2: PLC Settings for A/B Trigger from differential inputs (<PLC> = in category IPEngine/ProgrammableLogicController)

7.7.4 PLC Settings for A/B Trigger from single-ended inputs

This configuration maps the single-ended inputs to the A/B camera inputs: ISO_IN0 is mapped to the A signal and ISO_IN1 to the B signal see Table 7.3 (the visibility in the PF_GEVPlayer must be set to `Guru` for this purpose).

The AB Trigger feature is not available on all camera revisions, see Appendix B for a list of available features.

Feature	Value	Category
TriggerMode	On	AcquisitionControl
TriggerSource	ABTrigger	AcquisitionControl
PLC_I0	Line0	<PLC>/SignalRoutingBlock
PLC_I1	Line1	<PLC>/SignalRoutingBlock
PLC_Q6_Variable0	PLC_I0	<PLC>/LookupTable/Q6
PLC_Q6_Operator0	Or	<PLC>/LookupTable/Q6
PLC_Q6_Variable1	Zero	<PLC>/LookupTable/Q6
PLC_Q6_Operator1	Or	<PLC>/LookupTable/Q6
PLC_Q6_Variable2	Zero	<PLC>/LookupTable/Q6
PLC_Q6_Operator2	Or	<PLC>/LookupTable/Q6
PLC_Q6_Variable3	Zero	<PLC>/LookupTable/Q6
PLC_Q7_Variable0	PLC_I1	<PLC>/LookupTable/Q7
PLC_Q7_Operator0	Or	<PLC>/LookupTable/Q7
PLC_Q7_Variable1	Zero	<PLC>/LookupTable/Q7
PLC_Q7_Operator1	Or	<PLC>/LookupTable/Q7
PLC_Q7_Variable2	Zero	<PLC>/LookupTable/Q7
PLC_Q7_Operator2	Or	<PLC>/LookupTable/Q7
PLC_Q7_Variable3	Zero	<PLC>/LookupTable/Q7

Table 7.3: PLC Settings for A/B Trigger from single-ended inputs (<PLC> = in category IPEngine/ProgrammableLogicController)

7.8 Miscellaneous Properties

7.8.1 PixelFormat

The property `PixelFormat` (in category `ImageFormatControl`) sets the pixel format. For 10 bits and 12 bits there is a selection of plain or packed format. The plain format uses more bandwidth than the packed format, but is easier to process in the software. Table 7.4 shows the number of bits per pixel to are required for a pixel format. Fig. 7.5 shows the bit alignment of the packed pixel formats.

DataFormat	Bits per pixel
Mono8	8
Mono10	16
Mono10Packed	12
Mono12	16
Mono12Packed	12
Mono14	16
Mono16	16

Table 7.4: GigE pixel format overview

The DR1 colour camera models have the `BayerGB8` format. This should be used to display the debayered colour image in the PF_GEVPlayer display. To demodulate the image by the SDK the format `Mono8` must be used.

Mono10Packed																								
Byte	0								1								2							
BitNr	9	8	7	6	5	4	3	2	-	-	1	0	-	-	1	0	9	8	7	6	5	4	3	2
Pixel	Pixel A										Pixel B				Pixel A		Pixel B							

Mono12Packed																								
Byte	0								1								2							
BitNr	11	10	9	8	7	6	5	4	3	2	1	0	3	2	1	0	11	10	9	8	7	6	5	4
Pixel	Pixel A								Pixel B				Pixel A				Pixel B							

Figure 7.5: Packed Pixel Format

8

Mechanical Considerations

8.1 Mechanical Interface

During storage and transport, the camera should be protected against vibration, shock, moisture and dust. The original packaging protects the camera adequately from vibration and shock during storage and transport. Please either retain this packaging for possible later use or dispose of it according to local regulations.

8.1.1 Cameras with GigE Interface

Fig. 8.1 shows the mechanical drawing of the camera housing for the Photonfocus MV1-R1280-G2 camera series.

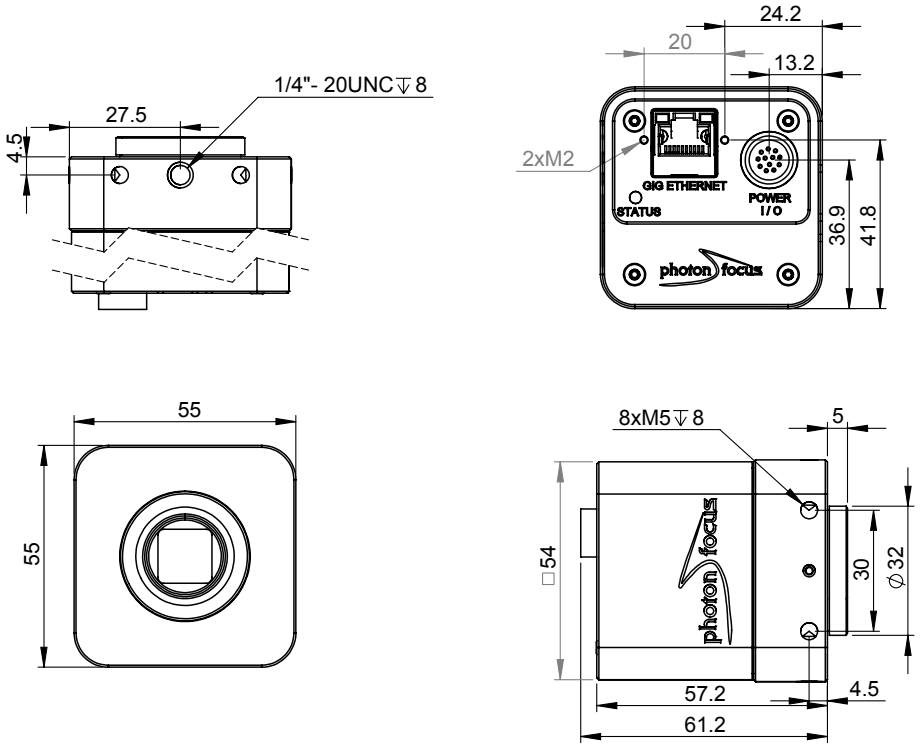

Figure 8.1: Mechanical dimensions of the Photonfocus MV1-R1280 GigE cameras

For long life and high accuracy operation, we highly recommend to mount the camera thermally coupled, so that the mounting acts as a heat sink. To verify proper mounting, camera temperature can be monitored using the GeniCam command `DeviceTemperature` under GEVDeviceControl.

8.2 Adjusting the Back Focus

The back focus of your Photonfocus camera is correctly adjusted in the production of the camera.

This section describes the procedure to adjust the back focus if you require that because e.g. you are using a special lens.

1. Screw a lens strongly into the camera's C-mount ring.
2. Unscrew the 3 small screws that lock the C-mount ring with a hex-wrench of size 0.89 mm. The position of the screws is shown in Fig. 8.2. The ring can now be screwn upwards or downwards by turning the lens.
3. To adjust the back focus fully open the aperture of the lens and set the focus to infinite.
4. Start the image acquisition and point the camera to a straight edge/line in a distance x (x = infinite distance of your lens) from the camera, e.g. a door frame.
5. Screw the ring upwards or downwards until the straight edge/line (distance: infinite) is also straight on the camera image.
6. Tighten the small screws. As the ring is locked, the lens can now be easily removed.

Figure 8.2: Position of the 3 small screws that lock C-mount.ring

8.3 CE compliance

The Photonfocus camera MV1-R1280-50-CL is in compliance with the below mentioned standards according to the provisions of European Standards Directives:

- EN 61 000 - 6 - 3 : 2001
- EN 61 000 - 6 - 2 : 2001
- EN 61 000 - 4 - 6 : 1996
- EN 61 000 - 4 - 4 : 1996
- EN 61 000 - 4 - 3 : 1996
- EN 61 000 - 4 - 2 : 1995
- EN 55 022 : 1994

9 Warranty

The manufacturer alone reserves the right to recognize warranty claims.

9.1 Warranty Terms

The manufacturer warrants to distributor and end customer that for a period of two years from the date of the shipment from manufacturer or distributor to end customer (the "Warranty Period") that:

- the product will substantially conform to the specifications set forth in the applicable documentation published by the manufacturer and accompanying said product, and
- the product shall be free from defects in materials and workmanship under normal use.

The distributor shall not make or pass on to any party any warranty or representation on behalf of the manufacturer other than or inconsistent with the above limited warranty set.

9.2 Warranty Claim

The above warranty does not apply to any product that has been modified or altered by any party other than manufacturer, or for any defects caused by any use of the product in a manner for which it was not designed, or by the negligence of any party other than manufacturer.

10

References

All referenced documents can be downloaded from our website at www.photonfocus.com.

AN007 Application Note "Camera Acquisition Modes", Photonfocus, March 2004

GEVQS GEVPlayer Quick Start Guide, Pleora Technologies. Included in eBUS installer.

MAN051 Manual "Photonfocus GigE Quick Start Guide", Photonfocus

PLC iPORT Programmable Logic Controller Reference Guide, Pleora Technologies. Included in GigE software package.

AN008 Application Note "Photometry versus Radiometry", Photonfocus, December 2004

AN026 Application Note "LFSR Test Images", Photonfocus, September 2005

A

Pinouts

A.1 Power Supply Connector

The power supply connectors are available from Hirose connectors at www.hirose-connectors.com. Fig. A.1 shows the power supply plug from the solder side. The pin assignment of the power supply plug is given in Table A.2.

It is extremely important that you apply the appropriate voltages to your camera. Incorrect voltages will damage or destroy the camera.

The connection of the input and output signals is described in Section 6.5.

A suitable power supply can be ordered from your Photonfocus dealership.

Connector Type	Order Nr.
12-pole Hirose HR10A-10P-12S soldering	110-0402-0
12-pole Hirose HR10A-10P-12SC crimping	110-0604-4

Table A.1: Power supply connectors (Hirose HR10 series, female connector)

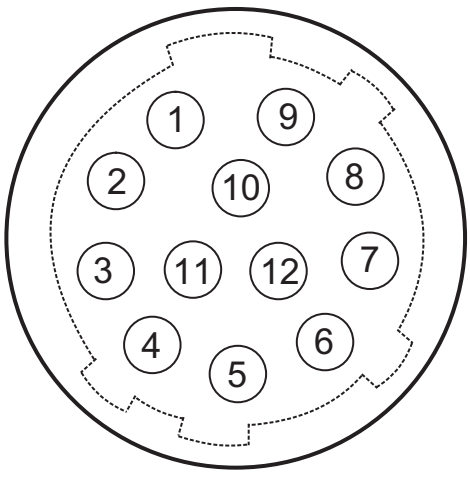

Figure A.1: Power supply connector, 12-pole female (rear view of connector, solder side)

Pin	I/O Type	Name	Description
1	PWR	CAMERA_GND	Camera GND, 0V
2	PWR	CAMERA_PWR	Camera Power 12V..24V
3	O	ISO_OUT0	Default Strobe out, internally Pulled up to ISO_PWR with 4k7 Resistor
4	I	ISO_INC0_N	INC0 differential input (G2: RS-422, H2: HTL), negative polarity
5	I	ISO_INC0_P	INC0 differential input (G2: RS-422, H2: HTL), positive polarity
6	PWR	ISO_PWR	Power supply 5V..24V for output signals; Do NOT connect to camera Power
7	I	ISO_IN0	IN0 input signal
8	O	ISO_OUT1 (MISC)	Q1 output from PLC, no Pull up to ISO_PWR ; can be used as additional output (by adding Pull up) or as controllable switch (max. 100mA, no capacitive or inductive load)
9	I	ISO_IN1(Trigger IN)	Default Trigger IN
10	I	ISO_INC1_N	INC1 differential input (G2: RS-422, H2: HTL), negative polarity
11	I	ISO_INC1_P	INC1 differential input (G2: RS-422, H2: HTL), positive polarity
12	PWR	ISO_GND	I/O GND, 0V

Table A.2: Power supply connector pin assignment

B

Camera Revisions

B.1 General Remarks

This chapter lists differences between the revisions of the camera models.

List of terms used in this chapter:

Standard Trigger Standard trigger features. Trigger Source: Free running, Software Trigger, Line1 Trigger, PLC_Q4 Trigger. Exposure Time Control: Camera-controlled, Trigger-controlled. Additional features: Trigger Delay, Burst Trigger and Strobe.

Counter Reset External Reset of image counter and real time counter by an external signal.

B.2 MV1-R1280-50-G2-16

	V1.0
ROI	yes
MROI	no
Decimation	no
Standard Trigger	yes
TriggerAcquisition	yes
AB Trigger	yes
Counter Reset External	yes
Multiple Slope	no
Hotpixel Correction	yes
Digital Gain / Offset	yes
Analog Gain	no
LUT	no
Crosshairs	yes
Status Line	yes
Test Images	yes

Table B.1: Revisions MV1-R1280-50-G2-16

C

Document Revision History

Revision	Date	Changes
1.0	April 2015	First version